Towards Knowledge Building:

Reflecting on Teachers' Roles and Professional Learning in Communities of Practice

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BA, Dip Ed, Dip Hum, M Ed St, MA

Thesis submitted in total fulfilment of the requirements
of the degree of Doctor of Philosophy

May 2003

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Abstract

This study was undertaken in conjunction with the Successful Integration of Learning Technologies (SILT) Project in Victorian state schools, and its purpose was to identify the forms of teachers' professional practice that enhance knowledge building, in order to inform teacher development policy and pre-service education. Knowledge building is based on a constructivist approach to learning and teaching, and this, in conjunction with the spread of learning technologies, is said to have greatly changed the role of the teacher in the classroom: from the expert dispensing knowledge to the facilitator of student learning.

Using an ethnographic approach based particularly on observation and reflective conversation with teacher participants, the study identified current and emerging roles of teachers using computers in their classrooms. Three substantive roles were identified: designing the learning environment, managing people and resources and mediating student learning. A fourth role, improving practice, captures the workplace learning that is recognised by all teachers in this study. Teachers demonstrated these interdependent roles to varying extents, individually and, in some cases, collaboratively. There were hints of specialisation that could lead to a future separation of roles, or aspects of roles.

By recording single instances of emerging practices as well as the more frequent occurrences, the findings indicated a range of characteristics pertaining to each role, presented as a framework, which can inform teacher education and lifelong learning. In turn, these were considered in light of Wenger's (1998) theory of communities of practice, in terms of individual classrooms and of schools as constellations of communities. Knowledge-building teachers were members of deep and strong local communities whose task was co-constructing knowledge. They recognised that technology could be used for consumption, (re)production and creation purposes, and they used open frameworks as structures, which allowed students to explore and construct knowledge. They also acted as brokers, crossing boundaries to communicate

with other communities. Technology was a medium for this communication, and a means of managing and storing knowledge objects.

This study suggests that teachers will become more involved in shaping their roles if they have space to reflect on current practice and to become more familiar with the frameworks, tools and resources available to them. Professional development strategies need to recognise workplace learning and to encourage teachers to make explicit their tacit knowledge, intertwining theory and practice and making new connections. The responsibility for this lies with teachers and their schools and systems, where structures and cultures will need to change to meet shared purposes within communities of practice, and to look outward to the wider society. Links between theory and practice will be enhanced by teacher-researcher partnerships that cross the boundary of practice and research, thereby connecting communities of practice.

Declaration

This is to certify that

i) The thesis comprises only my original work towards the PhD except where indicated in the Preface,
ii) Due acknowledgement has been made in the text to all other material used,
iii) The thesis is less than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices.

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Elizabeth Hartnell-Young

Preface

The following conference papers and publications also presented material from this research:

Hartnell-Young, E. (2000). *Teacher Learning in Technology Environments in Victorian Schools.* Paper presented at the Australian Association for Research in Education (AARE), Sydney, Australia.

Hartnell-Young, E. (2001a). *Successful Integration of Learning Technologies in School Classrooms (SILT).* Paper presented at the EdMedia 2001World Conference on Educational Multimedia, Hypermedia and Telecommunications, Tampere, Finland.

Hartnell-Young, E. (2001b). *Successful Integration of Learning Technologies in School Classrooms (SILT).* Paper presented at the Annual Postgraduate Research Conference, The University of Melbourne, Australia.

Hartnell-Young, E. (2002a). *From Facilitating to Knowledge-building: Teachers' roles in classrooms using computers.* Paper presented at the Annual Postgraduate Research Conference, The University of Melbourne, Australia.

Hartnell-Young, E. (2002b). *Teacher Learning and Professional Development in Technology Environments.* Paper presented at the 15th International Congress for School Effectiveness and Improvement, Copenhagen, Denmark.

Hartnell-Young, E. (2003a). From Facilitator to Knowledge-builder: A New Role for the Teacher of the Future. In A. McDougall & J. Murnane & C. Stacey & C. Dowling (Eds.), *ICT and the Teacher of the Future: Selected Papers from the International Federation for Information Processing Working Groups 3.1 and 3.3 Working Conference* (Vol. 23, pp. 53-55). Melbourne, Australia: Australian Computer Society.

Hartnell-Young, E. (2003b). *Knowledge-building among Teachers Using Computers in Classrooms.* Paper presented at the 16th International Congress for School Effectiveness and Improvement, Sydney, Australia.

Hartnell-Young, E., Haslam, F., & Neal, G. (2003). *Symposium: Learning With Technology: Multiple Perspectives.* Paper presented at the 16th International Congress for School Effectiveness and Improvement, Sydney, Australia.

Acknowledgements

This research was conducted in conjunction with the Successful Implementation of Learning Technologies (SILT) Project, a partnership commenced in 2000 between the Department of Education and Training (DE&T) in Victoria and The University of Sydney. In 2001 the project moved to The University of Melbourne. Throughout the study, my supervisor, Professor Peter Cuttance, modelled a constructivist approach, providing supportive structures that allowed open space and freedom for exploration. I have appreciated his support and advocacy, and the financial support offered through a University of Sydney Postgraduate Award and The University of Melbourne's Studentship.

I also appreciate the cooperation of the teachers and principals in the SILT schools. As we came to know each other better, we modelled a productive practitioner-researcher partnership. I know they often found the process challenging, and I hope that they also see rewards resulting from their participation, in their own practice. I thank the representatives of the Department of Education and Training (DE&T) in Victoria who facilitated access to background information.

During the period of this research, I lost two of my greatest supporters — my husband, Ross Hartnell, and my mother, Bette Kent —who died in 2000 and 2002, respectively. I know they would have been delighted to see this PhD completed. Those supporters who remain include the members of the SILT research team and the Centre for Applied Educational Research at The University of Melbourne, my extended family, and numerous friends, who have shared the journey, discussed the findings and challenged my thinking.

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Purpose of the study

Education reform movements in the western world in the late twentieth century espoused a more student-centred and constructivist approach to teaching and learning, with greater emphasis on understanding individual student talents and needs, as essential to reach the goal of higher levels of student achievement. The preferred role for teachers is as facilitators of student learning rather than instructors transmitting information, and this shift in role is said to be assisted by the spread of technology, which forces teachers to relinquish power over classroom knowledge (McRae, Ainsworth, Groves, Rowland, & Zbar, 2001), while also providing new opportunities for creating knowledge among teachers and students. Concurrently, an emphasis on curriculum standards and testing programs for students, and performance standards and competencies for teachers, provides an accountability framework at school, state and global levels. Research has shown that the individual teacher is enormously important in helping students develop positive attitudes to learning, and that teacher quality is more important than curriculum standards, class sizes or statewide testing programs in influencing differential learning outcomes achieved by students (Darling-Hammond, 2000; Rowe, 2002; Shulman, 1997). As a result, professional development programs have set out to increase teachers' skills and knowledge after their initial training. However a comprehensive picture of what teachers actually do with students is lacking, and therefore system-wide professional development largely remains uninformed by those for whom it is designed.

This study addresses a gap in the existing research in that it investigates the related notions of the teacher as a knowledge builder with students, and the teacher as a member of a profession of knowledge builders, as fundamental to an integrated set of teacher roles. While the teaching context for this study is classrooms using computers, the study does not focus on teachers' *technology* skills, but their *teaching* behaviours. It aims to provide a rich description of 21st century teaching by documenting and clarifying the

roles played by teachers who use computers with their classes. Its purpose is to inform teacher development policy and pre-service education at the broad scale, and to influence school organisation and teacher practice to meet current and future needs.

The underpinning research problem is to identify the characteristics of teachers' practice that enhance knowledge building in classrooms and across the teaching profession. In order to achieve the purpose of the study the subsidiary questions are:

- What current and emerging teacher roles are found in classrooms using computers?
- To what extent and under what conditions does knowledge building occur in each of these roles?
- What are the implications of the findings for teachers' professional learning and the development of new practices?

Background to the study

The imperative for knowledge building is driven by societal changes and certain paradoxes that affect the nature of schooling. Commentators like Drucker (1993) speak of *knowledge workers* and argue that knowledge is the only meaningful resource today. In this view, the traditional factors of production —land, labour and capital — have become secondary because they can be obtained easily if people have knowledge. The information revolution increases the capacity of the resource-rich to build their knowledge, while others, both whole countries and groups within countries, are left behind. Those with access to vast amounts of information can suffer from so-called *information overload* making it important to evaluate and communicate information wisely. Knowledge management — learning to know what we know and finding ways to organise it— has become a concern of organisations in light of the plethora of information available and the transience of a flexible workforce, while for others, access to information is still denied due to poor telecommunications or financial limitations.

Technology users are segmented into groups, leading Castells (1999) to suggest that the multimedia world will be populated by the *interacting* (those who can select their

multidirectional circuits of communication) and the *interacted* (those who are provided with a restricted number of pre-packaged choices). In this world, individuals can only cover a small amount of the potential for learning, so connecting with others and taking a team approach will be increasingly necessary. Paradoxically individual success is rewarded in schooling and in society, and international testing of students drives schools to work towards better individual student outcomes, while the culture of teaching appears reluctant to praise individual success within the profession. Increasing hours of work for all, including teachers, affect the partnerships that enhance student learning, yet working and learning in partnership to co-construct knowledge (Scardamalia & Bereiter, 1999) may be the most efficient means to move forward. In brief, these are the social issues that form the research context.

Australians in general tend to embrace technology innovations to a very high degree in various aspects of daily life (Australian Broadcasting Authority, 2001). In the State of Victoria a large investment of government funds into computer-based technologies in schools means that teachers are now expected to use computers for administration and curriculum purposes, thus creating a demand for teacher professional development and a need to understand more about teachers' learning. At the same time there are calls for a more constructivist approach to teacher development, and for more emphasis to be placed on sharing knowledge among teachers as members of a learning community. New knowledge is being constantly created by teachers through their approach to their work, but Hargreaves (1999) suggests this knowledge can be better managed to help a school realise its intellectual capital: the sum of its knowledge and abilities. Following Nonaka and Takeuchi (1995) who described knowledge-creating companies as building bridges in all directions between tacit knowledge (subjective, intuitive, knowledge of practice) and explicit knowledge (objective, easily-stored data), he urges schools to find ways to know what their members know. He encourages greater collaboration between researchers and teachers in the processes of creating knowledge, more sophisticated forms of validating knowledge and alternative forms of dissemination to the familiar top-down approaches. The dilemma, as Nonaka and Takeuchi suggest, is to avoid stiflingly formal knowledge management procedures in attempting to codify tacit knowledge.

This research was conducted in conjunction with the Successful Implementation of Learning Technologies (SILT) Project, a partnership established in 2000 between the then Department of Education, Employment and Training (DEET) in Victoria and the University of Sydney, to conduct research in classrooms using computers in the middle years of schooling (upper primary and lower secondary). In 2001 the Project moved to the University of Melbourne. I was drawn to this research after many years as a teacher, school principal and professional development consultant. Having owned a personal computer for twenty years, my interest in using technology is probably average for an Australian, but like many women, I became more excited about the potential for communication and social networking with the development of the Internet in the 1990s. Here was a tool for research and discussion, linking me with colleagues and friends in various locations.

While I could see that many teachers were interested in the potential, they felt overwhelmed by the technology. Years of working in isolation in the culture of schools made it a slow process to learn and share, while the top-down professional development on offer failed to inspire many teachers. However, through working with teachers in various projects I could see that given the opportunity and with a sense of purpose, they wanted to take on this innovation, and were quite happy to become learners once more. I felt I needed to understand more of teachers' classroom lives and how computers were being used in order to influence professional development policy. My dream is not just to see improvements in individual teachers but also to see them confident to engage in discussion and debate, opening their practice up to sharing and critique both locally and globally. I believe that teachers want to make a difference in education and society, and that schools and system structures and processes can either hinder or facilitate this. The enormity of world events during the period of this study reminded many of us that education has a social purpose. With this in mind, and a background focusing on social processes rather than psychological theory, my chosen frame for the analysis is based on a social theory — Wenger's community of practice (Wenger, 1998) —outlined in Chapter 2. While the concept of a learning community is promoted as a goal for schools,

it represents quite a cultural change for most (O'Neil, 1995). Yet technology provides opportunities to reach this goal, *if* they are recognised and taken up. Similarly it can give teachers a means for communication of ideas within and beyond their geographical space. My dream for knowledge building and sharing is perhaps better expressed by Stahl:

> …a networked globe where individual competition is replaced by collaborative cognition, social division of manual and mental labour is superseded by equal intellectual access and private ownership of socially created ideas succumbs to unfettered sharing (Stahl, 1999 p.610).

Teacher learning and professional development: the current situation

As noted above, this study is intended to influence teacher professional development, particularly through identifying the extent and means of teacher learning through practice. Professional development as a concept is not new. For many years education systems have recognised that teachers, once trained, need to continue learning on-the-job, and that in order to be successful, curriculum innovations should be accompanied by teacher development (Stenhouse, 1975). The strong effect of the teacher on student learning also demands that teachers do the best they possibly can, through continually reflecting on their classroom practice and applying their new knowledge to their work. Like many before them, Darling-Hammond (2000), Beare (2001) and Rowe (2002) argue that improved teacher quality can and must be achieved through on-going professional development. However in some cases authorities have interpreted this as meaning that training must be added on to any large-scale change, and implementation is patchy, or worse, unsuccessful. Teachers have been required to attend workshops offered by experts in teaching and learning, or in some cases, workshops provided by Education Department staff via a train-the-trainer model, while their own knowledge is sometimes undervalued or ignored. Some suggest this encourages a view of teaching as technical, learning as packaged, and teachers as passive learners (Lieberman, 1996) and is linked with a tendency to record and measure professional development by the amount of time spent in formal programs.

The need for the teacher to be a learner is rarely disputed in the current educational climate by teachers themselves, but the term *professional development* and its

abbreviation *PD* has been so often used in recent years that many teachers refer to *being pee-deed*, highlighting the transmissive nature of much of the delivery at system level. A recent report by Meredyth et al (DETYA, 1999) echoes this one-way view, using terms such as *delivery* and referring to teachers who *received* professional development.

Fullan (1993) argues that an appropriate combination of pressure and support is required for professional development to be successful. A top down approach of applying pressure without support can simply generate alienation and withdrawal, leading at best to superficial change. On the other hand, he says, support such as funding without pressure can result in change projects that do not focus on the important issues. This of course assumes that funding bodies have the correct answers. It is ironic that models of professional development which treat teachers as empty vessels ready to receive current innovations, simultaneously promote a constructivist view of the students as self-motivated, self-directed learners (Beattie, 1995). Consequently Day (1999) argues that for school reform to be effective, learning opportunities for teachers must model constructivism, taking into account the individual learning styles and career history of teachers as well as contextual factors such as school culture, support of colleagues and leaders, and the influence of governments.

In the constructivist view, the teacher is at all times a potential learner, able to make meaning out of experience individually and collaboratively. In light of this belief, school-based professional development has gained in importance in recent decades as teachers realise the value of learning situated in their normal work setting. A national survey of more than five thousand teachers in state, Catholic and independent schools in Australia found that nearly 80 per cent of them participated in professional development activities organised by their own school (McRae et al., 2001). However the survey had limitations. It measured input rather than outcomes, for both teachers and students, and the emphasis on the term *activity* used throughout the survey confirms a view of formal structured professional development, ignoring the contribution of reflective practice and informal, unstructured opportunities for teacher learning.

This study is based on a broader view of professional development than that described above, and currently experienced by many teachers in Victoria. Day offers a more comprehensive definition when he includes:

> all natural learning experiences and those conscious and planned activities, which are intended to be of direct or indirect benefit to the individual, group or school and which contribute, through these, to the quality of education in the classroom. It is the process by which, alone and with others, teachers review, renew and extend their commitment as change agents to the moral purposes of teaching; and by which they acquire and develop critically the knowledge, skills and emotional intelligence essential to good professional thinking, planning and practice with young children, young people and colleagues through each phase of their teaching lives (Day, 1999, p.4).

Day's definition demands that teachers consider their learning within a purposeful framework, asking why they are pursuing an activity and having learnt something new, seeking to apply it to their work to benefit the community. Seen this way, professional development has the dual purpose of moving forward or reforming schools while enhancing teacher skills, knowledge and professionalism. It can occur alone or with others in a social context, and it is not always planned. Teachers' learning can take many forms, both formal and informal, in or out of school, but all learning should be acknowledged and valued. Reflection is a means by which learning is recognised and knowledge evaluated, but, as noted above, in many cases education systems and school communities focus on the formal structured types of professional development and fail to record or value the ongoing informal learning of teachers, so that teachers themselves do not articulate or reflect on their learning a great deal.

While Lieberman (1996) identified only three settings in which teacher learning occurs — conferences and workshops, in-school activities such as coaching and action research, and networks or groups outside the school — Day adds the classroom as an additional setting where learning occurs through interaction with students. This study argues that since this is where teachers spend a great deal of time — it is after all their workplace — it is likely that much learning occurs in classrooms. Hoban (1997) describes three types of professional development models, which he names outside-in, inside-in and inside-outside. The outside-in models are those whereby information and theories in education are disseminated through training workshops, with the intention that teachers will take

up new ideas and practices. The success of these models, suggests Hoban, depends on the extent to which teachers accept the knowledge being presented as meaningful and valuable to them. Clark (2001) also argues that where teachers are not involved in framing the goals and means of professional development, it is bound to fail. One reason, according to Marris (1974, cited in Beattie, 1995, p.29) is that the decision-makers have themselves already gone through awareness-raising and thinking at the system level without allowing for individual and school-level response, thus failing to acknowledge the state of readiness of the target group. Hoban's second type, the inside-in models, draws upon the knowledge and experience of the participating teachers, encouraging them to reflect on and explore their ideas in their own context. This is a more constructivist approach, and teachers therefore take more responsibility for their own learning, but unless they collaborate with others, may be limited in their growth. Hoban's third type, the inside-outside models, aim to develop a community of discourse drawing upon the experience-based knowledge of teachers and the knowledge of researchers and others.

This traditional dialectic between practice and theory, represented by teachers on the one hand and researchers on the other, is being challenged as inappropriate for the 21st century. Hargreaves (1999) suggests that new modes of educational research should be explored, including training and supporting more teachers in research skills, searching for links between existing bodies of knowledge and supporting collaboration between all parts of the education system. Technology provides us with tools for communicating ideas and recording new knowledge, and openness and trust are required to develop leaning communities in new spaces. If learning is a process involving activity and reflection and both scientific and spontaneous concepts (Vygotsky, 1962) there can be no limits to where it takes place. However a recent report suggested that the greatest barrier to success is the lack of coordination between pre-service teacher education, continuing professional development and school reform efforts (Department of Education Science and Training, 2001). Similarly Selfe (1999) argues for a holistic approach looking at the relationship between computer technology, virtual environments, language, and society from a range of theoretical perspectives, both in teacher education programs and in the profession. Otherwise, she believes, we are in

danger of drastically misinterpreting how technology and education relate to one another within our existing educational systems.

Learning with computers: the Victorian context

It is often thought that a culture of early adoption of change and a capacity to take risks has led to valuable experimental projects in Australia. National policies promoting a knowledge society imply and expect wide-ranging use of technology to support lifelong learning and recent Australian research has identified the extent of technology provision and use across the nation (Cuttance & Innovation and Best Practice Consortium, 2001). For example 15 per cent of Year 8 students in Australia experience considerable computer use in mathematics classes, as compared with seven per cent of their counterparts in the United States, Austria, and the Netherlands, and two per cent in Japan (DETYA, 1999). This is justified by a belief that using computers has a positive impact on student achievement and attitudes, as reported by Sivin-Kachala and Bialo (1994), who analysed 133 research reviews and project reports. They suggest the degree of effectiveness is influenced by several factors: the student population, instructional design, the teacher's role, how students are grouped, and the level of student access to technology. However it is still early days for the widespread use of computers in schools. While many reports extol the potential benefits of computer use in classrooms, international surveys suggest that around the world, the use of information technology in classrooms is the exception rather than the rule. Research in Australia can therefore inform decisions elsewhere.

The setting for this study comprises classrooms in Victorian schools and the associated learning spaces, physical and virtual, that are created around them, but it assumes a much broader *learning spac*e. In Victoria, pressure and support have been provided for teachers at system and school level since the 1980s. The Victorian Education Department of Education and Training has encouraged teachers to use computers for both teaching and administration and supported this through the subsidised provision of computers to schools. The Department supported its policy decision to achieve a student to computer ratio of less than 5:1 (2001) with the provision of professional development opportunities at a cost of fifty-six million dollars over three years from 1998

(Department of Education Victoria, 1998a). With the establishment of an Internet provider for Victorian schools, all teachers and students were provided with email capability, commonly referred to as *edumail*, and a small allocation of space on a server to store messages and files. This system also enabled teachers to establish distribution lists that they could use for shared communication.

Recognising that lack of access to computers is frequently mentioned as a major impediment to teachers' learning (DETYA, 1999) the Department in Victoria initiated the Notebooks for Teachers and Principals program, which commenced late in 1998 with the aim of providing 37,000 laptop computers to teachers in Victorian state schools over a five-year period. The purpose was to support teachers and principals to effectively integrate the use of learning technologies into classroom and administrative practices and to improve teacher skills in using learning technologies in the delivery of curriculum (Matthews, 2000). Through this initiative, the Department also hoped to enhance the professional status of teachers. Once teachers received a computer, they were required to participate in forty hours of professional development, which many recipients preferred to undertake in school with their colleagues (McDougall, Nicholson, & Marshall, 2000). An evaluation study showed that teachers generally increased their use of computers for research, classroom practice and administration, but many were concerned about the time required to learn about the innovation. Female teachers in particular appeared to increase their use of computers, and consequently their competence (Matthews, 2000). Blyth's study of teachers with laptops in one school indicated that teachers set high expectations for integrating computers into learning, but the professional development available to them was focused on the technology itself. He found that progress was slow as teachers tried to find authentic purposes for computer use (Blyth, 2002). Another Australian study in one school reported that giving teachers laptop computers and professional development support resulted in improvement in their interest, confidence and competency (Narracott, 1995). In this case, teachers were able to participate in activities appropriate and relevant to their personal needs, and in general they had a positive attitude to the professional development programs.

Pressure and support for teachers is also provided through the Curriculum and Standards Frameworks (CSF II), which set levels for student achievement from Preparatory grade to Year 10 and are the basis for standards-based assessment in Victoria. They support teachers by providing examples of suitable activities using computers in each key learning area. They also attempt to classify and provide some sequence in the use of technology in the categories of file management, word processing, graphics, multimedia, electronic communication, spreadsheet, desktop publishing, data logging and simulation/modelling (Board of Studies, 2000). Teachers are expected to assess student progress and report to parents on the learning outcomes listed in the frameworks. Other support materials developed by the Victorian Curriculum and Assessment Authority (VCAA) are provided on the Department's web portal *SOFWeb* <www.sofweb.vic.gov.au>, including sample units of work linking learning outcomes in the Key Learning Areas with the technology applications recommended at each level. The intention is to encourage teachers to more quickly integrate technology as a means of achieving student outcomes.

Navigator Schools

In addition to lack of access to computers and connectivity, the main barriers to Australian teachers developing improved classroom practice with information technology have been identified as lack of time to experiment with technologies and plan lessons using technology; lack of knowledge or understanding of what software to use, how to integrate it into the curriculum, and how to organise classroom activities; and lack of knowledge and support for resolving technical and logistical problems in the classroom (DETYA, 1999). In Victoria, the Navigator Schools Project was launched in October 1995, with the objectives of creating a network of exemplar schools sharing with others, displaying evidence of additional teaching and learning outcomes in a technology-rich environment and providing a professional development resource for Victorian teachers and principals. Seven Navigator Schools were established to provide accessible working models of educational environments incorporating learning technologies, where teachers could visit and engage in activities known as practicums (Department of Education Victoria, 1998a). The Project was based to some extent on the Apple Classrooms of Tomorrow (ACOT) Project in the United States (Dwyer, 1994).

An expectation of the Navigator Schools Project was that routine access to a range of learning technologies, networked communications and a commitment to changed classroom practice would lead to enhanced student learning outcomes, including levels of achievement, engagement, motivation and understanding; provide students, teachers and administrators with the infrastructure to engage in knowledge-building activities such as managing, organising and distributing information, and extending learning beyond the classroom to include resources and collaborators in other places, both local and global (Department of Education Victoria, 1998b). The seven schools in the Project were each given extensive computer resources and funding for a project officer, and were expected to offer site visits and professional development in teaching and learning with computers to local teachers and international visitors.

The model of teaching promoted by the Navigator Schools blended aspects of constructivism, authentic learning, inquiry learning, multiple intelligences (Gardner, 1984), Bloom's Taxonomy (Bloom, 1956) and Six Thinking Hats (de Bono, 1992, 2000) into a pattern of sequenced and integrated knowledge, skills and attitudes, according to Dunbar, Clarkson, & Toomey (2000). It was developed by the project officers and refined in conjunction with teachers. A Departmental report on the Navigator Schools claimed that teaching and learning in these schools underwent a change towards cooperative learning and student decision-making, among other things. The increasing use of technology extended what was possible in classroom practice, resulting in greater student involvement in project learning, increased learning in groups, a shift in the teacher's role and attitude from being a source of knowledge to being a coach and mentor, and a greater willingness on the part of students to take responsibility for their own learning (Department of Education Victoria, 1998b).

Teachers in Navigator Schools used curriculum and standards frameworks as a basis for teaching while emphasising higher order thinking skills and adopting a life long learning perspective. In implementing the Project the schools were reported to have effectively integrated technology into all learning areas and into their administrative practices. Teachers claimed improvements in student learning outcomes including investigating,

searching for information, researching, solving problems, presenting information, communicating in ways appropriate to an audience, designing, being creative, working cooperatively, keyboarding, learning autonomously, learning independently and sharing skills and ideas. They also reported improvement in student attitudes and values including engagement in learning, enjoyment of learning, experimenting with own learning, extending themselves, participating in learning and self directed learning (Dunbar et al., 2000). Two schools in the current study were involved as Navigator Schools since the program's inception.

eLearning strategy

By 2002, the Navigator Schools group was disbanded, and a new term — eLearning — now describes the use of technologies in schools. The advice to schools on the Department's eLearning web site suggests that the speed with which eLearning can be integrated into the school curriculum depends on teacher attitudes and skills, and that professional development should be provided for teachers as a key focus of the eLearning plan (Department of Education & Training Victoria, 2002). It identifies three factors that contribute to teachers' innovative use of eLearning: teachers' commitment to their own and students' learning, collegiality in school and locally, and access to ICT tools and the pedagogical context for their use. The advice also suggests that skills for effective eLearning should be identified in each school and targets should be set for achieving these skills over time. As part of the eLearning strategy the Department provides funding for schools to build *pods* — small rooms of computers accessed from a number of surrounding classrooms. The term has previously been used to refer to a cluster of computers arranged to facilitate discussion in a classroom (Poole, 1995; Selfe, 1992), but its use in Victoria generally refers to a separate space. This innovation is an attempt to provide regular access to computers for students, particularly in secondary schools, and is perhaps a transition between the traditional plan of classrooms and the future envisaged by Beare (1998), who predicts that future classrooms will be constructed to provide easy access to libraries, databanks and computer gateways, and to accommodate flexible time for learning.

Developments and changes in curriculum, learning theories and resources have forced teachers to reflect on their skills, their roles and the very source of their authority. The policy shift from inputs to outcomes, while clearly student-centred, demands knowledgeable and expert teachers, and is therefore is in some tension with the broad classroom reform agenda to replace teacher-dominated classrooms and information-transmission with a model of the learners constructing knowledge and taking responsibility for their own learning. The implementation of new technologies, with which students are often more familiar than their teachers, has the potential to give students greater power over their learning, and to leave teachers feeling deskilled. It is therefore not surprising that Australian teachers report the development of personal information and communication technology skills as their greatest area of need (McRae et al., 2001) and that moves are being made to develop competency frameworks for teachers (Department of Education Science and Training, 2002). This study attempts to place this concern in the broader context of purposeful teacher development in a knowledge-building society.

Overview of the study

This chapter has established the geographical and policy context for the study, indicating that teachers in Victoria work in a context that is supportive of new approaches to teaching and learning and relatively rich in technology resources. Chapter 2 reviews literature relating to current approaches to teaching and learning, particularly social constructivism, and outlines a social theory of learning as a framework for later analysis. It discusses the promise of technology and the ways computers are used in learning activities, in light of their potential for knowledge building. The chapter also considers literature relating to current and emerging teacher roles in classrooms and to teacher learning and professional development in a socio-cultural context, leading to a conceptual framework for this study. Chapter 3 discusses methodology and argues the case for the chosen design for this qualitative study, which is intended to model reflective practice with, and for, teachers. The research findings are presented in Chapters 4, 5, 6, and 7, following the conceptual framework of the four roles of teachers discussed in Chapter 2: designing the learning environment, managing people and resources, mediating student learning, and improving practice. Finally Chapter 8 brings

together these findings into an integrated set of characteristics of knowledge-building teachers, presented as a framework that can be used with and by teachers. These characteristics are then considered in terms of the theory of communities of practice. The chapter then suggests implications of the research, particularly for professional development and teacher education.

Chapter 2 : Knowledge building in a social context: a review of literature

This chapter reviews literature that illuminates the concept of *knowledge building*, presented in three parts. Knowledge building is based on Dewey's view of knowledge as a product constructed by people and containing the meaning of objects and events (Dewey, 1910). Learning is the process by which knowledge is created. Knowledge itself must be in the world, rather than in the mind (Bereiter & Scardamalia, 1998), so that knowledge itself is in the form of objects (including principles and theories) to be considered, criticised and improved by the learners. Knowledge building is activity directed outward towards the creation of knowledge itself, while learning is a personal consequence of this process, the aspect that is directed to enhancing one's own abilities and dispositions.

In this study, knowledge building broadly encompasses the activities of both teachers and students in creating, sharing and evaluating knowledge. The first part of this chapter considers recent major influences on teaching and learning in order to describe the current context of teachers' roles. It briefly describes aspects of constructivism, an approach to teaching and learning that has influenced teacher education and the education reform movement in the last decades of the twentieth century. It specifically explores the socio-cultural perspective and outlines a social theory of learning: communities of practice. The influence of technology on teaching and learning, the links and tensions between technology and constructivism, and their capacity for supporting knowledge building are also reviewed. The second part discusses the many and varied classroom roles of teachers identified in the literature, including new roles, particularly in relation to other teachers. The third part of the chapter briefly reviews current literature relating to teachers' learning and professional development, based on a constructivist approach that supports knowledge building. A conceptual model for this study, based on an understanding of the literature, is presented at the end of the chapter.

Teaching and learning as knowledge building

In contrast to conceptions of teaching as purely the transmission of a certain body of knowledge from experts *to* novice learners, a view of teaching as knowledge building is based on creating new knowledge *with* learners, often in a context of uncertainties. This view has developed as communication technologies challenge teachers' control of student learning, and education reformers call for constructivist approaches to schooling in a social context. These important influences on teaching and learning are discussed in the following pages.

Constructivism

Constructivism in its various forms builds on the learning theories of Dewey and Piaget, who have influenced recent generations of teachers in Western countries, taking them from a behaviourist or instructional paradigm to a more open and creative model. In Piaget's view, understanding is built up step-by-step through discovery and active involvement, and discovery must be encouraged if individuals are to be capable of production and creativity and not simply repetition (Piaget, 1973). This approach to learning demands greater flexibility in learning than could be expected in approaches based on the transmission of knowledge from teacher to learner and requires a different understanding of what knowledge consists of. Within constructivism two main streams comprise those who focus on the individual's cognitive development (cognitive processing) and others who see learning as always requiring a social setting (social constructivism). The result is knowledge that is temporary, developmental, non-objective, internally constructed and socially and culturally mediated (Fosnot, 1996).

As learners hold a variety of prior views, they construct meaning at a personal level, so that constructivism is referred to as student-centred, in contrast to a teacher-centred, transmissive approach. Damarin (1996) suggests that the student is in fact not a single knower, but a confederation of many knowers: travelling from one situation to another, the student draws on the knowledge appropriate to the new situation. The teacher's role then, is to support the growth of each situational knower as well as their confidence to move between situations such as home and school, among social subgroups within these, and among different school situations, both formal and informal.

In a constructivist teacher-student relationship, teachers require students to take responsibility for making their own meaning, rather than accepting prefabricated meanings of information or instruction. It is therefore seen as substantially different from the relationship whereby the teacher as expert transfers knowledge to the student. Key attributes of a constructivist classroom are said to include student initiative, higher-level thinking, social discourse between students and with teachers and the use of raw data, primary sources and interactive materials to encourage multiple perspectives on an issue (Brooks & Brooks, 1993). Learners are expected to work towards autonomy and self-regulated learning, and to achieve greater understanding of the processes of learning itself. Students become the observers of their own behaviour, and through reflection gauge their own progress, judge the extent to which their knowledge is effective action and gain the insight necessary to improve their own learning (Brown & Palincsar, 1989). The influence of cognitive psychologists has encouraged teachers to seek a greater understanding of the diverse learning styles of individuals (Kolb, 1984a), and the labelling of *multiple intelligences* including the linguistic, logico-mathematical, spatial and musical, among others (Gardner, 1984, 1999), has led to an emphasis on addressing individual student style preferences and developing areas of perceived deficit.

Other related influences on the early years of schooling in Victorian schools, which could flow through to the middle years covered in this study, include the Italian Reggio Emilia approach which emphasises endless ways of individual expression by providing a large variety of materials. Teacher autonomy is evident in this approach, due to the absence of teacher manuals, curriculum guides, or achievement tests. Teachers plan with the children continuously, based on the evaluation of work as it progresses. As the children undertake complex individual or small group collaborative tasks over a period of several days or weeks, the teachers examine the work each day and discuss with the children their ideas and the possibilities of new options for the following days. Planning decisions can be made on the basis of what individual or groups of children have found interesting, stimulating, puzzling, or challenging. Teachers therefore become skilled observers of children in order to inform their curriculum planning and implementation (Katz & Chard, 1996).

The social context

The influences on learning of the school culture, and of other learners, have long been recognised. Nearly one hundred years ago Dewey (1910) suggested that teachers must be intelligent students of both individual mental operations and the effects of school conditions on those operations, and that with this knowledge should be trusted to develop methods to gain results in particular curriculum areas. At the classroom scale, although much of Piaget's work was focused on the individual learner he did not deny the important role of other people in the learning process, and as Beveridge (1997) argues, did not imply simply that children could learn on their own. Both teachers and other students are therefore part of the individual's learning process. The work of Vygotsky has been a major influence on constructivist thinking since the translation of his works from Russian into English (Vygotsky, 1978; Vygotsky, 1962). In his research he examined, among other things, the relationship between the development of psychological foundations for instruction and instruction itself, and found that rather than development preceding instruction (along the lines of Piaget's stages of development) it interacts in a complex relationship with instruction. He also found that intellectual development is not compartmentalised and that the different school subjects interact in contributing to it: each facilitates the learning of the others. In attempting to measure children's mental development he gave them a task beyond their present capabilities, then provided some assistance. With this co-operation, some children of the same mental age could solve problems designed for those four years older, while others could not go beyond problems designed for children one year older. He labelled the gap between the actual mental age and the level reached with assistance the zone of proximal development (ZPD).

A socio-cultural approach sees the classroom as a mini-society engaged in activity, discourse and reflection. According to Moll, Vygotsky saw teaching and learning as the most fundamental socio-cultural activity (Moll, 1990) and he showed the importance of both teachers and peers in mediating learning. With appropriate help or mediation involving language, gesture, or even the observation of a successful performance, particularly by a peer, students are likely to internalise concepts and language. However these concepts are not to be considered in isolation. Like Dewey (1910), for whom

meaning depended on the whole, Vygotsky (1962) emphasised whole activities rather than skills and sub-skills. But unlike Dewey, he believed that the development of spontaneous concepts, through the child's own mental efforts, and the nonspontaneous (or scientific) concepts, decisively influenced by adults, are part of the same process.

In the social context of the classroom, collaboration is a term used to describe attempts of both teachers and students to work together with a common goal or purpose (based on the Latin *co-labore:* to work together). For the purposes of this study the definition provided by Kaye (1992, p.4) is helpful. He sees collaborative learning as "the acquisition by individuals of knowledge, skills or attitudes occurring as the result of group interaction". As he suggests, collaborative learning appears to be more common in the work environment than in formal education, due perhaps to the pervasive effect of individual assessment in an essentially competitive environment. The assumptions underpinning collaborative learning are based on socio-cultural theory and Vygotskian understandings of the benefits of peer mediation, and include the importance of sharing different perspectives, engaging in conversation and writing to make understandings explicit and to share knowledge. Other aspects of the rationale for collaborative learning are based on the way work is organised in groups and teams in society, and the motivational benefits of being a member of a healthy group.

Research into co-operative learning methods in the classroom indicates that improved achievement can result where the goals are shared by the group and each individual is accountable to the group, thus taking responsibility for completion of the task and enhancing group processes (Slavin, 1990). Cooperative processes can also lead to increased individual self-esteem, through participation in group achievements, with the consequence of more independent and self-paced learning (Cherednichenko, Hooley, Kruger, & Moore, 2001). For Kaye, the purpose for collaboration appears to be the acquisition of individual knowledge, skills and attitudes, while in contrast, Scardamalia and Bereiter (1999) argue that where a collaborative knowledge-building approach is adopted, the work to be done in schools becomes the construction of collective knowledge. This means that teachers and students are participants in a learning organisation. For schools intent on achieving outcomes the paramount purpose for

students is this personal learning, but this can reduce tasks simply to learning activities with no broader purpose, even when they are couched in problem-solving or project-based learning terms (which are in the view of Scardamalia and Bereiter less radical approaches). Project-based learning is often focused on the production of tangible products, such as multi-media presentations (the containers of knowledge), whereas the focus in knowledge building is on the knowledge itself, its physical representation being secondary.

While some constructivists remain tied to the classroom in the construction of knowledge, the proponents of situated learning argue that meaning is a product of activity and the culture and context in which that activity occurs (Brown & Palincsar, 1989; Brown, Collins, & Duguid, 1989; Lave & Wenger, 1994), and they take into account the immediate physical context as well as the social and historical context (Brown & Duguid, 1996). Students in a situated learning environment, they say, are engaged in *authentic* learning activities, which have a purpose that goes beyond simply demonstrating mastery of tasks, allowing students to learn knowledge and skills in real contexts where they are applicable. However, the interpretation of what is authentic for diverse learners can be problematic for teachers (Honebein, Duffy, & Fushman, 1992). On one hand, Wilson (1993) proposes that authentic activities must be located in the actual situation of their creation and use, not in the artificial environment of the school. Countering this, Honebein et al. suggest that within the education framework, the authenticity of the learning activity refers to the activity of the *learner* in the learning environment relative to the environment in which the learning will be used. They suggest that an activity is authentic when the learner has ownership, in that it is not seen purely as the teacher's task. Furthermore, authenticity can mean that learning takes on a social purpose in addition to the individual's purpose, and the two interact (Resnick, 1991). She argues that social behaviour is not only an influence on thought, but a manifestation of cognitive processing under particular conditions and that in contrast to classroom situations, everyday situations demand shared cognition through group problem-solving, reliance on external tools and resources and a much greater emphasis on the manipulation of objects rather than abstractions.

A focus on social purpose leads to notions of community. Lave and Wenger see the individual learner as part of a community of practice, where learning takes place through the sharing of purposeful, patterned activity, as a newcomer, or novice, moves from the periphery to the centre, becoming an expert within that community (Lave & Wenger, 1994). They use the term *legitimate peripheral participation* to describe engagement in social practice that entails learning as an integral constituent. Peripherality is a positive and dynamic term, they suggest, contrasting with unrelatedness or irrelevance. It suggests an opening and a movement toward expertise. However the expert-novice distinction is problematic for some, as it emphasises unequal power relations. The capacity of all members of the community to contribute and learn from each other, and for any member to create new knowledge, is not accepted if the labels of expert and novice are strongly felt (Damarin, 1996). It would appear that the smaller the unit of analysis, the more likely that the expert-novice distinction can be sustained, as each individual has expertise in something which their neighbour does not. However even on the larger scale, such as within a school, there are clearly people who by virtue of their interest or experience are more expert than others in specific areas. This is not to say that the expert Science teacher is an expert with computers. Hence learning is an activity for all.

A social theory of learning

Wenger's (1998) social theory of learning, and in particular, the concept of the community of practice is fundamental to this study, and will be described here in some detail. His theory is useful because it addresses learning in the context of social practice or mutual engagement in action, and considers learning as fundamental to the creation of the social order. *Practice* is the social production of meaning, involving negotiation, participation and reification (projection of meanings giving them weight) and is the source of coherence of a community. Practice is itself a learning process so that the community is an emergent structure with complex boundaries and peripheries. Wenger does not see theory and practice as antonyms, but existing in a complex interactive relationship, so that even when it produces theory, practice is practice, as described above. While practice is always located in time and space, the relations that constitute practice are primarily defined by learning.

Wenger suggests that indicators of such a community include sustained mutual relationships, shared ways of engaging in doing things together, rapid flow of information and propagation of innovation, and knowing what others can do. However they should not be considered in isolation but in relation to the rest of the world. He argues that while communities create boundaries through formal and informal means — certification, language, and style — the processes of reification and participation can also create continuities across boundaries. To apply his theory to a school, the building as an artefact is appropriated and reified in different ways by the communities of practice within it, acting as a nexus of perspectives and at times a form of coordination among perspectives. On the other hand, people participate in multiple communities of practice within that building, as teachers belong to several curriculum or welfare teams, for example, or meet with several classes between which they can span boundaries. Through two types of connections: *boundary objects* (artefacts, documents, terms, concepts) and *brokering* (connections made by people) practices can influence each other. Boundary objects essential to this study include curriculum and standards frameworks documents, school policy documents and the language associated with computers. Brokers are those people — teachers, principals, researchers, and students — able to make connections across communities of practice and open new possibilities for meaning. Because they operate at the periphery rather than at the core of a practice, they need to balance a role between membership of one community, which brings legitimacy and credibility, and keeping a distance, which allows for different perspectives.

In terms of education, Wenger argues that identities and modes of belonging are more important than skills and information. Education is not limited to schooling, but is a mutual development process between communities and individuals, forming new identities. Designing education then, is not just planning a curriculum, but creating an architecture that allows the formation of identities. For this reason, Wenger suggests three infrastructures: the first, places of *engagement* for people; the second, materials and experiences with which to build an image of the world and themselves *(imagination)* and the third, ways of having an effect on the world and making their actions matter (*alignment*). Within each infrastructure, he suggests, there are specific areas to develop,

although the list is not exhaustive. Opportunities for engagement, for example, arise through mutual and shared activities among students and others, through challenges and responsibilities that call upon learners' knowledgeability and encourage them to explore new territories, and through continuity to develop shared practice and a long-term commitment. It appears that facilities of engagement can assist knowledge building particularly by bringing people together, encouraging shared discourse and recording information. The three aspects of imagination, Wenger suggests, are orientation: locating self and learning about a wider world, reflection: looking at our situations with new eyes and exploration: reinventing the self and in the process reinventing the world. He argues that imagination is the way a learning community can expand the definition of its enterprise. This is where knowledge building can be enhanced by time off for reflection and conversation, exploration and play. The third aspect of Wenger's learning architecture is alignment, which encompasses larger-scale understanding of power relations and how to have an effect on the world. Therefore he suggests that the learning community must push its boundaries and interact with other communities of practice in a purposeful way, it must link participation inside with that outside the community (eg. through multi-membership of its members in other communities), it must use the styles and discourses of the areas it wants to affect, and it must become involved in the organisational arrangements of its own institution. It is therefore deep and wide, able to know what it knows and to use this in a range of arenas. This learning architecture is summarised in Table 2.1.

Table 2.1 Wenger's architecture for learning

Facilities of Engagement	Facilities of Imagination	Facilities of Alignment
Mutuality Interactional facilities (physical and virtual spaces) Joint tasks Peripherality: including boundary encounters, open houses	*Orientation* Location in space Location in time Location in meaning Location in power	*Convergence* Common focus, vision, values Allegiance Leadership Inspiration
Competence Initiative and knowledgeability: including prior experience Accountability: occasions for evaluation Tools: including discourses, concepts	*Reflection* Models and patterns Time off Conversations	*Coordination* Standards and methods Plans and schedules Communication Boundary facilities, brokers Boundary objects Support for multimembership Feedback facilities Data collection
Continuity Reificative memory: inc. documentation Participative memory: inc. generational encounters	*Exploration* Trying things out Play	*Jurisdiction* Policies Processes Distribution of authority

Wenger also suggests four dimensions in designing for learning: not as alternatives, but to be combined productively. The first is participation and reification: design becomes a question of what to reify and when, while participation asks who to involve and when. The second dimension is the designed and the emergent, which sees practice as response to design, adapting it to include the emergent and make it an opportunity. This leads Wenger to argue that a robust design for learning is a minimalist design allowing for opportunity. Third, design must create relations between the local and the global. Therefore communities of practice have to be involved in designing their own learning. He argues that no community can fully design the learning of another, but equally no community can fully design its own learning. The final dimension is identification and negotiability: where design represents a perspective and a proposal of identity. As such it creates a focus for identification and a bid for ownership of meaning that is then negotiated by members of the community.

The importance of communities of practice to knowledge building is also understood in the recent literature on communities and social capital (for example, Centre for Research and Learning in Regional Australia, 2002), which holds that social capital contains sets

of knowledge and identity resources which reside in individuals and communities, and these resources are activated and shared through social interaction (Falk & Kilpatrick, 2000). Knowledge resources are accessed not only internally with local communities of interaction, but also externally from those communities to which individuals have weak ties. Identity resources build a sense of belonging and encourage participation, as well as providing the framework for people to re-orient their views of self and others in order to be willing to act in new ways. In the following pages technology is considered as a resource in this enterprise.

The promise of technology

Definitions of the term *technology* variously refer to a collection of artefacts, a form of human action, a form of knowledge or a social process. Technology is usually thought of as the transformation or manipulation of nature to satisfy human needs and goals. While technologies have been found in schools in various forms for many years, the term *learning technology* has been frequently used in Victorian schools, and in system-wide curriculum and planning documents, to describe computer-based resources and tools (Directorate of School Education, 1994). Accordingly, when the term *technology* is used in this review of literature, it refers to computer-based and multimedia hardware and software, personal computers and their peripherals such as laptops, printers, scanners, digital cameras, data loggers, and other electronic items found in school classrooms. Mobile phones and other new products might soon join this list. In recent years many educators have preferred the acronym ICT (for information and communication technology) to take the emphasis off technology as a one-way delivery medium and to promote its use as a communication tool. The focus is still, however, on the tool, artefact or object. However even this definition could be too limiting, as Burbules & Callister (2000) suggest that technologies should be considered more as a collaborative space where people can be brought together. Certainly the potential of communication technologies to challenge our social perceptions of time and space cannot be denied (Castells, 1999).

Since the new forms of technology represent a rapid change, albeit created by people themselves, some educators pin their hopes on the potential of technology to drive

educational reform, and in a socio-cultural framework, to act upon society to reach a desired state of change. It is clear from the preceding discussion that the prevailing educational theories and approaches influence the interaction between teachers and students, and in moving towards a more constructivist classroom the teachers' roles reflect the shift of responsibility towards the learners. Goble and Porter (1977) suggest that significant change from instruction towards construction occurs when the rate of accumulation of new data forces a realisation that knowledge is infinite and cannot be possessed, nor is it absolute and definite. Students who can access a much wider range of sources of information via email and Internet challenge the control over content formerly held by teachers and education systems (Baker, Gearhart, & Herman, 1994).

While logic suggests that teachers can choose to take a constructivist approach irrespective of the technology available (Davies, 1988; Hooper & Hannafin, 1991), others point out that in spite of the encouragement of research, publications and professional development, the movement towards constructivism has been slow (Carey, 1993). In a study based on interviews and observations with forty-seven teachers, Dexter, Anderson and Becker (1999) found that technology was more likely to have helped these teachers make changes they already wanted to make, rather than to change the way they taught, and that their development as constructivist teachers was associated with reflecting on their teaching. Similarly Venezky and Davis (2001) found that ICT was rarely a catalyst by itself for school change, but acted as a powerful lever. Individual teachers cannot take on all the responsibility for change, as they are acting in a broader social setting where the school culture and expectations of student achievement often work against constructivism in practice (Becker & Riel, 1999). However the spread of computers, enabling an information revolution, appears to have created the sort of realisation predicted by Goble and Porter, leading many of those who argue for educational reform to see computers as a catalyst to achieve the change they desire (Carney, 1998; David & Shields, 1991; Fisher, Dwyer, & Yocam, 1996).

Uses for technology

The potential of computer technology to create learning resources and products has been harnessed enthusiastically by teachers and instructional designers. Particularly in the early days of computer use, these products were based on a behaviourist model of teaching or knowledge transfer (Brown & Duguid, 1996; Zucchermaglio, 1992) in contrast to a constructivist approach focusing on learning either through cognitive information processing, which stresses efficient processing strategies, or social and collaborative knowledge building. Because of this there are several areas of tension between constructivists and many educational technologists, particularly to do with differences in their beliefs about learning, and the role that technology plays in the process. In a challenging discussion Bednar, Cunningham, Duffy and Perry (1992), proponents of constructivism, argue that the designers of computer learning programs use a behaviourist model incompatible with constructivist learning when developing new products. They claim that when designers identify content components and classify them based on the nature of the content and the goals of the learner, they are pre-specifying all of the relevant content and the logical dependencies between the components. This takes away the opportunity for the learner to construct meaning and build knowledge.

In a similar vein, Petraglia (1998a) argues that some educational technologists have misunderstood constructivism in their attempts to develop learning materials and environments that correspond to the real world, without the involvement of the learners. He criticises this as a false approach to situated learning. Like Lave and Wenger (1994) he focuses on openings for learning rather than constraints of form and content. In his view these *pre-authenticated* materials contradict constructivism, because they deliver problems for the consideration of learners rather than address the problems facing the learner at the time. The argument is that in constructivism the content cannot be pre-specified, and while a central body of information in a domain can be identified, teachers and designers cannot define the boundaries of what may be relevant. If the goal is to move the learner into thinking in the knowledge domain as an expert user of that domain might think, to act as a geographer or a historian, such limits on content deny

possibilities of knowledge creation. Bednar et al. (1992) argue strongly that this aim cannot be achieved without taking into account the individual learner and consequently that one educational software product cannot be created to suit all learners. On the other side of the debate, and taking a pragmatic stance, Merrill (1992) argues that it would be impossible for instructional designers to meet the constructivist view that every learner is unique and must have control of his or her own instruction. While agreeing that active learning is important and knowledge is constructed from experience, he argues for a more socially agreed meaning and rejects the extreme position that all meaning is constructed by the learner, since there are times when shared meaning is necessary, for example in reading sounds, responding to red lights, or carrying out heart surgery. He suggests that to insist on all instruction occurring only in the context of use is to deny some of the great advantages of learning from instruction. In contrast to the proponents of situated learning he emphatically insists that at some point abstractions must be decontextualised if the student is to gain the maximum benefit and ability to transfer generalities and tools to new situations.

Constructivist approaches might be possible with both open and closed software programs, and this is where the role of teachers is crucial. In discussing their experience with technology as a tool for active learning, Imison and Taylor (2001) believe they show how it can become an active scaffolding partner in the learning process, giving feedback to students, while others express concern that the computer cannot provide the necessary scaffolded social encounters (Crook, 1994). Social constructivists argue that dialogue with others is the source of mediation and scaffolding, and in light of this Leask and Pachler (2001) argue that with limited availability of intelligent software, learning is more likely to occur through interactions between teachers and students while using computers than it is through interactions with the technology itself. Similarly Mercer and Fisher (1998), highlighting the communicative aspects of learning, refer to their theoretical approach as neo-Vygotskian, as it treats learning as culturally based, not just culturally influenced, and social rather than individual. It is, they say, a process of *teaching-and-learning* rather than solely learning. They admit that there is little evidence of this approach influencing educational software, but suggest there is potential for developing theory around situated learning with computers, problem-solving and

cognitive apprenticeship, where students interact with professionals (Brown & Campione, 1994). Scardamalia and Bereiter dispute the term *cognitive apprenticeship.* They argue that since students are not apprentice teachers, and teachers are not practitioners of the disciplines they teach, the apprenticeship metaphor does not fit. They also find it anti-constructivist and unsustainable due to the demands it places on the expert's time and goodwill (Scardamalia & Bereiter, 1996b). They prefer the term *collaborative knowledge building* because unlike a professional research group, which is expected to produce knowledge new to the world and to solve problems that have never been solved before, students generally only produce knowledge that is new to them. Furthermore, they argue, the knowledge constructed by students will mostly be derived from reference books and other secondary sources, and only occasionally from experimentation and primary data.

Taking a different view, the Cognition and Technology Group at Vanderbilt University works on a blend of ecological psychology and constructivism. On the ecological side they believe that there is structure in the world —both the physical world and the epistemological world — that places constraints on knowing. On the constructivist side, they believe that there are sufficient degrees of freedom in the structure of the physical and epistemological worlds to allow people to construct their own personal theories of their environments, of what is known or believed by others about those environments and of themselves. Like Vygotsky, they emphasise the social nature of cognition (Cognition and Technology Group at Vanderbilt, 1992).

As Castells (1999) noted, some views of technology tend to place people in passive relationships, as if they have no power to control it for their learning. However we should remember how technology originated, and for what purposes people have created it. A social-constructivist interpretation of technology would suggest that technology is to a large degree, or even completely, socially determined. People are in a position to claim back technology for the purpose of knowledge building if they desire, but for some teachers this requires greater clarity about what is actually happening and what is possible.

Technology for knowledge building in schools

The discussion above is important in linking the purpose of technology use to a theory or approach to learning. Early in the days of ICT, Illich (1971) argued that technology could be used to develop independence and learning on the one hand, or bureaucracy and teaching on the other, pointing out that for a similar cost to the transmission of television programs, opportunities for free expression could be provided to whole populations. This distinction is central to the argument for knowledge-building technology. Without a learning purpose, computer use is the end in itself, and quantifying usage becomes the measure of success. Numerous authors and educators have observed three distinct ways of thinking about and using technology, which, from a learner's point of view, can be organised along a continuum, as presented in Table 2.2.

Table 2.2 Approaches to the use of technology in learning

Relationship with tools and Knowledge	**Consumer**	**(Re)producer**	**Knowledge Creator**
Locus of control (Hay, 1996)	Teacher	Student	Community of practice
Learning approach (Lajoie & Derry, 1993)	Behaviourist	Situational	Social constructivist Situated Apprenticeship
Computer Software (content) (Imison & Taylor, 2001)	Instruction: content-specific	Construction: content explored or manipulated	Co-construction: Content free and shared
Computer Software (purpose) (Jonassen, 2000)		Productivity tools	Mind tools
Computer Software (form) (Leask & Pachler, 2001)	Closed: Drill and practice		Open: Generic software for word processing, database etc.
Student Activities (Hay, 1996)	Receiving	Entering	Creating
Multimedia (Heppell, 1993)	Narrative	Interactive	Participative
Role vis à vis games (Cahn, 2002)	Viewer	Player	Creator
Internet Use (Wiegand, 1998)	Searching and downloading	Collaborative publishing	Asynchronous & synchronous collaborative projects
Intranet Use (Leafe, 2001)	Browsing	Interacting	Collaborating

This continuum is labelled from a knowledge-building perspective, beginning with consumption of information via technology, to (re)production of information using

technology, and lastly the creation of new knowledge using technology. In terms of pedagogy, the continuum ranges from the behaviourist whereby the locus of control is with a teacher or a computer-as-teacher, to the cognitivist, where control is in the hands of the individual learner, and the computer is a resource, and then to forms of situated learning in a community of practice. According to Lajoie and Derry (1993) this allows for choice where either can be appropriate depending on the context. On the other hand others have observed and postulated a development in stages over this continuum of computer use. Heppell (1993) identified three stages in students' use of multimedia: a narrative stage, where students watch and note, an interactive stage, where they choose and do, and a participative stage, where they contribute and create. He argues that these form a taxonomy in which the first two stages are much more frequent in the classroom. The Student Youth Network, successful winners of a community FM radio licence in Melbourne in 2001, put forward in its submission the philosophy that young people need to be *creators not consumers* of this form of communication technology (Van Eeden, 2001) while Cahn (2002) sees the users as VPC's —Viewers, Players and Creators — and the computer as a metamedium: a medium for making other media. If creation is the focus, it could be argued that even the use of web authoring programs could be disempowering, in that they hide the underlying hypertext markup language (html) from the gaze of the creator. In any case, while the distinction is clear, the notion of stages may prove to be rather too lock-step in a world of many access points whereas the important distinction is the relationship of the learner with the information.

Leafe (2001) describes Intranet use (such as within a school) as browsing, interacting or collaborating. Similarly, Wiegand (1998) suggests dimensions along which Internet use might be measured, such as the degree of independence displayed by students in searching for information, and the extent of collaboration rather than cooperation. His examples include accessing information, collaborative publishing, asynchronous or synchronous collaborative learning with remote peers, external collaborative projects with experts and virtual learning environments. However others suggest that is the very nature of navigating through a web site is an active relationship and Tapscott sees time spent on the Internet not as passive consumption but as active time for reading,

investigating, developing skills and problem-solving (Tapscott, 1998). He even sees the waiting time as useful for analysing, evaluating, composing thoughts and writing, reminding us that observers should not make hasty judgements, and that all types of activity have their place. Hay (1996) attempts to draw together some of the concerns of the various theorists by including the work of situated cognition theorists, constructivists and instructionists in student activities. Like Burbules and Callister (2000) he suggests that this environment provides creative space where students can critique the truth and practices of others, and create new knowledge.

The effect of teachers in establishing the environment and mediating student learning through questioning and critique might be the difference between classifying uses of technology as passive or active. Imison and Taylor (2001) use the labels *instruction* (content-specific, drill and practice), *construction* (generic software, simulations) and *co-construction* (communication) to classify types of software and their classroom uses, but they argue that the contribution of technology to co-construction has more to do with the contexts teachers create, than the software itself. Jonassen (2000) refers to a dichotomy, which separates *productivity* tools from the more valuable *mindtools*: those that support knowledge construction, explorations, learning by doing and by conversing. He includes as mindtools databases, computer concept maps, spreadsheets, expert systems, microworlds, live conversation environments, multimedia publishing tools and intentional search engines, but does not include the Internet, word processors or graphics programs. However he concedes that his construct of *mindtool* is based on the tool enhancing the students' capacity to think deeply about the content they are learning, and that this may be possible with some productivity tools.

Leask and Pachler (2001) take up this part of the argument, arguing that generic software for word-processing, databases and spreadsheets, which helps users to process information, engage in abstract thinking, make knowledge construction processes apparent and build classification systems, is liberating and empowering because it allows for cognitive and creative thinking. It is in essence *empty*, allowing space for thinking and learning. Pachler suggests that enabling users to create and distribute their own work makes them active participants in the culture creation process, but they need

to be taught basic and higher order skills such as electronic/informatic, visual and critical media literacies to avoid being exploited by software producers and distributors (Pachler, 2001). It seems logical that both teachers and students acquire these critical literacies.

The literature reviewed above indicates that introducing technology *per se* will not necessarily result in knowledge building. Although learning can take place across the continuum, implicit in most of these label sets is a belief that activities resulting in knowledge creation are the most desirable, and that teachers themselves need to move towards the qualities of flexibility, networking and creativity which are required outcomes for students (Hargreaves, 1999). As McKenzie (1998) argues, a focus on use and activity is not sufficient; teachers' understandings and theories of learning, whatever they may be, must inform their integration of computers.

Research into technology uses

It is likely that classroom life is not as easily classified as Table 2.2 and the related discussion suggests, and that teachers and students engage in activities of all types depending on context and purpose. A report commissioned by the Government of Victoria found that young people had a strong relationship with technology as consumers, particularly of entertainment, but were less likely to be creators. (It should be noted that their definition of consumption included email use.) Students mainly used the Internet for email (68%), research for school projects (58%), personal research (52%)and music (48%). More than one third also used the Internet for games, entertainment and chat rooms. Significantly more females (81%) than males (53%) used email (Hill and Knowlton and Nexus Research, 2001).

The research literature provides several examples of creation activities as learners (teachers and students) interact using communications technologies. Synchronous communication such as video-conferencing and Internet relay chat takes place in real time, while asynchronous communication forms such as email, listserves and threaded discussion are not time-specific. They have both efficiency effects and social systems effects (Sproull & Kiesler, 1991) as speedy discourse can support knowledge building

through problem-solving and information sharing, while text-based forms such as email and threaded discussion provide a means of archiving thoughts as well as requiring their clarification before committing them to an audience. The reflective conversations and group problem solving, which can take place in this way, can build a professional community where teachers participate in discourse about improving practice. Discourse in this case is a resource for constructing statements about the world and coordinating engagement in practice (Wenger, 1998). In a study of the collaborative development of problem-solving curriculum units among school teachers using an email list, Hawkes (2000) identified some protocols which can assist communication, such as the use of a moderator, observing emerging rules of email etiquette, acknowledging contributions and focusing on specific topics. However, as with many new developments, much is unknown about electronic discourse. Where online environments are subject to rules of engagement a tension can arise between the spontaneous and the reflective, and the sociability preceding collaboration and knowledge building with others might be absent (Sorensen & Takle, 2001). The time required to participate in these communities and the level of inclusion of those who rarely participate, or simply *lurk,* can also be an inhibiting factor.

A desire to archive and manage the developing knowledge generated electronically has led to developments such as CSILE (Computer Supported Intentional Learning Environments) consisting of contributions to a community database, which resides on a server and is accessible to everyone in the network. Whereas typical school projects often involve producing an object, such as an illustrated report or a Web page, CSILE's objects are simply notes or composites of notes, addressed implicitly *to whom it may concern,* to which others respond on the basis of their content, not their production values. Thus, the knowledge represented by notes in the database is preserved and continually available for search, retrieval, comment, and revision, while the database as a whole serves to objectify the advancing knowledge of the group (Scardamalia & Bereiter, 1996a). This means that students are engaged in the production of knowledge objects rather than media objects or the containers of knowledge.

A similarly sophisticated process of collaborative knowledge building in Finland uses an inquiry learning process and the distributed expertise of the participants supported by an electronic storage space, a discussion space, a *jam session* module for the free flow of ideas and a library including material produced by participants (Muukonen, Hakkarainen, Lipponen, & Leinonen, 1999). Like Hawkes, they conclude however, that participants could better use the inbuilt structure of scaffolds if a tutor were introduced into the group until a more productive pattern of interaction was established. The failure of such knowledge-building environments, according to Stahl (1999) is that people avoid using them, due in part to the demands of learning to use a new format, acquiring the equipment, checking regularly for incoming messages and letting people know that they are communicating through it. It appears that a critical mass of adoption by one's communication partners is necessary for this type of community of practice to function well.

Electronic communication within organisations promises to subvert power differentials by offering freedom of communication with everyone, independent of status, and therefore the potential to enhance sharing of knowledge (Castells, 1999). Internet-based storage of and access to knowledge objects represents not only a resource for the community of learners, but a shift in the power relationship between creator and consumer. However at least one study undertaken within a university illustrates that large organisations can maintain their older corporate structure after the introduction of electronic communication tools (Ducheneaut, 2002). In spite of the networked capabilities, email communication in that study conformed to the established hierarchy.

The distinction set up in Table 2.2 has been challenged by Burbules and Callister (2000) who argue, in their discussion of hypertext and hypermedia, that hypertext systems have the capacity to both impose patterns of organisation on existing information and to facilitate the user's ability to create new patterns of organisation. This, they say, challenges the notion of a sharp distinction between accessing and producing new knowledge. Paradoxically, it can be argued that this has the potential to limit knowledge building. One example is the rapidly expanding access to the work of artists and writers on the Internet without reference to its creator (Amerika, n.d.). The issue, as Amerika

sees it, is that such work takes information out of the world of material goods and puts it into the virtual domain of digital reproduction, manipulation, and dissemination, forcing us to rethink the notion of intellectual property. While this alone is not concerning, in a world where individual intellectual property is guarded and valued, he wonders how creative people will be paid, and if they are not paid, how will the continued creation and distribution of such work be assured?

Roles and relationships in knowledge-building classrooms

While this study is based in the context of computer-users, it takes the view that it is people, not computers, who create change. In this section, literature relating to the emerging roles of teachers in classrooms is considered. It does not extend to all roles teachers might play in a school, but focuses on those classrooms roles relating to students, and associated knowledge-building roles relating mainly to other teachers. Interaction with students is still based upon the social setting of the classroom but also occurs through electronic interaction, while increasingly interaction with other teachers is made possible through technology. While some of the literature appears to place teachers in a defensive position, facing challenges from technology (Ministerial Advisory Council on the Quality of Teaching, 1997) the converse is that teachers are being enabled to create new classroom roles and relationships and to develop new pedagogies, which interact with technology to incorporate its potential benefits (Crook, 1991). When computers are introduced they create new contexts and environments of practice, changing work patterns, roles, procedures, perceptions of work possibilities and organisational groupings, thus allowing other changes to occur. Lankshear (1997) refers to these unexpected outcomes as second level effects.

As Heppell (1993) suggested, there is some evidence that classroom applications of technology evolve in stages, moving from the simple, passive or consumption activities to more creative uses. Empirical studies by Kerr (1991) and Hadley and Sheingold (1993) noted that teachers changed their role from being the centre of classroom attention to being a mentor or guide over a period of three to five years. Stages in instructional change have also been identified in the Apple Classrooms of Tomorrow (ACOT) Project in the United States and labelled entry, adoption, adaptation,

appropriation and invention (Dwyer, Ringstaff, & Sandholtz, 1991). However it is only in the latter two stages that new types of student activities appear to have commenced. The Project supplied computers in each classroom, rather than in a separate laboratory, and encouraged their use at all appropriate times. After four years teachers were experimenting with new kinds of tasks for students, encouraging far more collaboration, modifying the physical layout of the classrooms and modifying the class schedule to permit longer time for project work. It is however likely that time was not the only determining factor, and Dwyer et al. suggest that such changes can only occur when teachers' beliefs about instruction and learning change. The notion of stages may prove to be focused too much on the individual rather than taking into account the social context, which may need to be changed. Ravitz, Becker and Wong (2000) used a survey methodology to investigate teachers using computers and found that those with a constructivist approach used computers in more varied and powerful ways, had greater technical expertise, and used computers more frequently with students. Baker et al. (1994) found that elementary teachers were less innovative than secondary teachers in teaching with technology, while secondary teachers appeared to take on new understandings about students' roles in their own learning. For the purposes of teacher development and efficiency in knowledge building it would be helpful to understand whether teachers and students can take up computer use at any point along the continuum in Table 2.2, or whether a progression over time is required.

There are claims of technology being used in innovative ways in Australia to restructure classrooms, implement new instructional techniques, and transform student and teacher roles (DEETYA, 1996). Underpinning the use of technology in the classroom is the sense of efficacy — ability to make a difference — which teachers bring to their work. Hill and Russell (1999) suggest that this sense of efficacy is influenced by a belief that all students are capable of learning, given the right support, and where this occurs, teachers take on responsibility for the progress of students. On the other hand, Petraglia asserts that constructivism has been appropriated and rendered harmless by being incorporated into traditional hierarchies such as teacher-student roles and fact-based textbooks, and not allowed to challenge the basic educational framework. He claims that

teachers have exerted their power in the face of a theory which, when taken to the extreme, challenges their role in the learning process (Petraglia, 1998b).

Teachers as facilitators

An over-arching term often used to refer to teachers in the constructivist classroom is *facilitator*, which Rogers (1969) described as setting the mood or climate of the class, clarifying purpose for individuals and the group, and making the widest range of resources available. A facilitator relies on students to be motivated by a desire to implement the purposes that have meaning for them, and acts as a flexible resource for their use. A facilitator, according to Rogers, accepts intellectual content and emotionalised attitudes in the classroom and takes initiative in sharing personal thoughts and feelings. He or she remains alert to the expressions indicative of deep or strong feelings while also endeavouring to recognise and accept his or her own limitations.

Others have added to this role description, although all appear to be based on the model of one teacher to many students, reinforcing the individualism of teaching. In discussing education reform, Means and Olsen (1994) suggest that teachers no longer have total control of the direction of instruction, since a focus on authentic, challenging tasks lends itself to collaborative work, and the teacher becomes a facilitator and coach. Driver, Asoko, Leach and Mortimer and Scott (1994) suggest that the teacher's role is to provide the physical experiences whereby students can engage with others in attempting to understand and interpret phenomena, and to encourage reflection. Jones, Valdez, Nowakowski, and Rasmussen (1995) describe the teacher as a facilitator engaging in negotiation, stimulating and monitoring project work, but not controlling. They suggest that as facilitators, teachers provide rich learning environments, experiences, and activities; create opportunities for students to work collaboratively, to solve problems, do authentic tasks, and share knowledge and responsibility facilitators. Echoing Rogers's awareness of personal characteristics, Lang, McBeath and Hébert (1995) suggest that to be a successful facilitator of learning, a teacher must be empathetic, warm, caring, open and genuine, positive and respectful of others and interested in learning for self and others. Recent awareness of emotional intelligence (Goleman, 1999) also indicates that this is an important area in professional relationships. In

addition to these characteristics, a facilitator must be a capable communicator, able to provide specific feedback. The teacher then is concerned with the physical environment and resources, the class climate, learning activities and content as well as feelings and emotions. The teacher models learning and coaches, mediates and gives feedback to other learners. Given the extent of these definitions, it is rather surprising that some observers believe that the introduction of computers into classrooms has the effect of making all teachers facilitators (Fisher et al., 1996; Tinkler, Lepani, & Mitchell, 1996).

If teachers are facilitators, in the ideal constructivist classroom they facilitate the learning of students who are autonomous, self-regulated, or self-directed, learners. This includes actively acquiring and transforming information, using metacognitive processes such as discriminating relevant from irrelevant information, connecting new information with prior knowledge or skills and planning particular performance routines (Mandinach & Cline, 1994). Goodman (1990) and Freire (1993) describe teachers as liberators freeing learners to take risks, while many teachers are developing strategies that they believe will result in students being less dependent on them than in previous teacher-student relationships. However Ball and Cohen (1999) suggest that teachers need to know more about learning and about pedagogy, about how the curriculum is constructed and how to develop a classroom culture that supports learning.

Scardamalia and Bereiter (1997) argue that teachers need not be subject matter experts if they are *adventuresome* learners and are supported by knowledge resources. But Jamieson (2000) argues strongly, using his higher education experience, that teachers have a role in both content and process. Without a content to teach, he believes, there is no teaching method. At the core of the teaching process, including the use of any telecommunications media, is the way the students are brought into engagement with the specific content of their learning by teachers. He believes that research which narrowly conceptualises teacher as users of a technology through which teaching is conducted, ignores their critical role concerning how the content is represented to the students, and how they structure the student learning experience.

Teachers are still required where students are autonomous learners, although their roles are different to those in transmissive learning, and, according to Boud, (1982) they must not deny their competence and authority. He argues that developing autonomy does not simply involve removing structured teaching, and may in fact require a greater degree of structure. Explicit teaching also has a place in the knowledge-building classroom because in schools, as in every organisation, there is information to be learned and skills to be acquired for productive work Sometimes these can be learned informally as one goes along, but often it is expedient to teach them in a direct manner so as to ensure that everyone learns them and can focus on the main task (Scardamalia & Bereiter, 1999). As a retort to those who believe that authentic, situated approaches devalue the explicit and abstract, and allow them no place in the classroom, Brown and Duguid (1996) argue that explication and abstraction are themselves situated social practices, developed in the process of ongoing activity. Problems only arise, they suggest, when the abstractions are detached from the practices in which they were created, and possibly even imposed on another practice.

Diaz et al. (1990) suggest two teaching behaviours that encourage student self-regulation or autonomy: the verbalisation of plans, rationales and goals, and the gradual and sensitive withdrawal from the regulatory role. Knowledge-building teachers need to take account of the differential needs for structure among the learners, and adapt accordingly. In light of current concern about boys' education (Hill & Russell, 1999), Rowe (2002) claims that boys need highly structured lessons with an emphasis on short-term challenging targets and frequent changes of activity. He also suggests more teacher-directed classroom activities rather than group work, and clear objectives, detailed, simple instructions and clear assessment criteria.

Since the literature clearly suggests teachers will be required rather than dispensed with, the specific areas of their work in the classroom context are described further in the following pages.

Participating in the design of the learning environment

In discussing leadership roles in building learning organisations, Senge (1990) argues that the most important role is that of designer. While the functions of design are often invisible, he suggests that they must include clear purpose and vision, policies, strategies and structures, and effective learning processes. Teachers are leaders in a school and are therefore critically involved in this important role.

Wenger (1998, p. 228) defines design as a "systematic, planned and reflexive colonisation of time and space in the service of an undertaking". He includes the production of artefacts and the design of social processes, so that one can design systems of accountability, roles and work processes, but suggests that practice itself cannot be designed. Therefore in the classroom as a community of practice people can design a curriculum, but not learning. Learning can be designed for, but it cannot be designed. Wenger argues that the relation of design to practice is always indirect: practice is not a result of design, but a response to it, which means that unexpected outcomes may occur. Design needs to include emergent practice, and to be opportunistic rather than rigid, so that a minimalist design is likely to be robust. Further he argues that designing for learning cannot be based on a division of labour between learners and non-learners, nor vested in a management community. Rather, communities of practice must be involved in the design of their own learning — while at the same time accessing other practices — in three dimensions: engagement, imagination and alignment.

In terms of design for education, Wenger suggests that communities need to be concerned with the four dimensions previously outlined under Table 2.1. The first, balancing participation (learners negotiating meaning for themselves) and reification (codification of knowledge through language or curriculum frameworks) requires teachers to consider when one or the other is most appropriate and even to question how much learning itself should be reified as a process. Secondly, they need to consider both the designed (or planned) and the emergent, and to be opportunistic, since teaching does not necessarily result in learning but is one of the contributing resources. They need to look outward, connecting the depth of the local with the breadth of the global, and

connecting education with other practices. Finally, they need to consider the competing sources of meaningful identity for students and staff, and offer new possibilities for participation in the face of possible alienation.

Designing curriculum

At present, although new technologies allow students more control over their learning, teachers are still mainly responsible for designing the environment for learning (Needham, 1986). One of the challenges of the constructivist approach is that real constructivist contexts are those which seem empty, but are in fact the result of a great deal of analysis, organization and planning of possible educational interactions (Zucchermaglio, 1992). Elements of design include the macro-scale curriculum and standards frameworks and global testing mandated in several education systems, which, some believe, allow teachers little control over curriculum content, although they can directly influence micro-scale grouping and spatial arrangements within the classroom (Cuban, 1984; De Marrais & LeCompte, 1999). Others see frameworks as providing a basis, which can be filled with a wide range of learning activities devised by teachers and students.

Scardamalia and Bereiter (1999) have experimented with including students in curriculum planning in the United States. Using a database similar to the Victorian Curriculum and Standards Frameworks (Board of Studies, 2000), students linked their work to appropriate objectives and commented on the relationships, and identified what they saw as additional objectives worth specifying. The project demonstrated that students could make useful contributions to curriculum planning. However in another study, Bober, Sullivan, Lowther and Harrison (1998) found that teachers did not value highly the process of involving students in making decisions about what they will learn and how they will learn it, and suggest that teachers need to be more explicit with students about the intent of their classroom practices, discussing with them why various practices have been selected.

In terms of planning for technology use, Loveless, De Voogd and Bolin (2001) suggest that teachers need to be aware of the range of resources and ways of working with

technology to support the curriculum at the planning stage. This includes the learning objectives, technology capability which can support or be developed through the learning experience, technology skills or techniques required to realise the activity, the range of teaching strategies, and assessment of both domain knowledge and technology skills and capabilities. Teachers' knowledge and choice of resources can be limited by practical factors such as budget or domain knowledge, while with the plethora of resources available via the Internet, they are often overwhelmed by the amount of information on classroom topics and hard-pressed to find time to assess its quality. When choosing software and multimedia products, teachers implementing a constructivist approach can use the same criteria they would apply to any resources, some of which are implied in Table 2.2. These might include the extent to which the material is presented in the context of a real world problem, whether it attempts to activate prior knowledge or experience, and to demonstrate exemplars rather than merely tell information about what is to be learned. Teachers would also ask if the product allows learners the opportunity to practice or apply their newly learned knowledge or skill and if it provides techniques that encourage learners to integrate the new knowledge or skill into their everyday life. In judging whether authentic knowledge building is going on, the question to ask is not whether students are using multimedia products or the Internet as opposed to reading books but whether they are trying to solve knowledge problems (Scardamalia & Bereiter, 1999).

As well as electronic resources, situated learning demands that contributions of adults other than the designated teachers must be incorporated, and while these can be expedited through the use of communication technologies, the process creates new demands on teachers. There is also the possibility of creating high-quality resources to suit the specific context, and in a study in one school, several teachers thought that in the future teaching would be more dynamic because technology would enhance teachers' ability to be creative and make teaching resources themselves (Reid, 2002).

Physical space

In spite of the influence of social-constructivist views, the physical context in which teaching and learning takes place is frequently ignored in much of the literature, which

appears to describe a relationship unrelated to the physical location of teachers and students, unless to focus on areas such as classroom climate (Jamieson, Fisher, Gilding, Taylor, & Trevitt, 2000). An awareness of the interaction between people and place is a consideration when designing the learning environment at the macro and micro scales, because

> Space is neither innocent nor neutral: it is an instrument of the political; it has a performative aspect whoever inhabits it; it works on its occupants. At the micro level, space prohibits, decides what may occur, lays down the law, implies a certain order, commands and locates bodies (Pouler, 1994, p.175).

Even Castells (1999), who argues that the space of places is being replaced in the network society by the space of flows (of information), believes that schools will remain as physical communities. Research evidence indicates that the care and maintenance of the built environment is an important factor in learning, and capital investment in school infrastructure appears to have a positive effect on attitudes and behaviour and relationships among staff and students (Fisher, 2001; PricewaterhouseCoopers, 2001). School and classroom layout can affect the interactions of teachers and students and opportunities for collaboration between teachers, an important part of the knowledge-building process (Nias, 1987).

The relatively unchanged design of school buildings in Victoria in the last century shows an allocation of space more influenced by architectural and financial considerations than by teaching and learning principles or collaborative management practices. For some teachers, anxieties about information technology are compounded when they are required to work with outdated equipment and poorly designed facilities (Office of Technology Assessment, 1995). Secondary schools typically experience the separation of teachers' offices and staff rooms from student learning areas or classrooms, while many designs limit flexible use of indoor and outdoor space. Now the inclusion of information and communication technologies allows for the creation of virtual learning spaces interacting with the physical spaces and raises new issues. Paradoxically, social interaction in working and learning is changing to become at once more collaborative and more individualistic: increasingly the workplace demands team structures and

processes while individualised and self-paced learning methods using ICT are being promoted, and performance management systems focus on individuals.

The concepts of openness and flexibility are emerging as key considerations, including the concept of a loose-fit building where a teaching and learning workshop allows for experimentation with a range of teaching and learning approaches (Jamieson et al., 2000). Heppell (1993) suggests two future building scenarios: one in which schools resemble open-plan offices for flexible work groups and self-paced study, and the other using high bandwidth, networks and quality projection equipment to allow for social learning in flexible spaces. Salisbury's (1996) future schools consist of spaces designed for discipline-oriented learning (which he rather surprisingly calls *labs).* Some of these will be mobile units, similar to those that already visit schools, shopping centres and other public places. In addition, technology support areas servicing the physical and the virtual environments are now essential, according to Fisher (1994) and space must be allocated to take account of this need.

The concept of flexibility extends to capturing the *pedagogical moment* (van Manen, 1991) where the teacher must act on the spur of the moment to do something pedagogically appropriate for the learner(s). Similarly, *just-in-time* learning (Ausubel, 1968) and learner autonomy and self-management are characteristics that are logically supported by facilities available on a *just-in-time* basis (Jamieson et al., 2000). Purpose-built secondary schools incorporating these characteristics have recently opened in Australia (Lake, 2003) and the Netherlands (vanDieten, 2003).

The relationship between learner and context is dialogic in that while the context impacts upon the activities of teachers and students, their activities also act upon that context. Hence the rhetoric claims that experience and knowledge of teachers and students can be called upon to inform and drive the process of change to enhance learning across the school (Directorate of School Education, 1994), to inform the design of virtual environments and as Fisher claims, to redesign existing schools through incorporating design tasks within the curriculum (Rennick, 2002).

Organisational and management roles

Within the designed spaces, teachers play a role in taking care of, or managing, the people and the available resources, although the school sets many of the parameters for this activity. In outward looking learning communities this includes managing links with numerous outside organisations and individuals who can support the work of the school and provide role models. Constructivist principles of flexibility and openness, collaborative practices, and student participation in decision-making can be employed in teachers' management roles.

Research in the middle years of schooling in Victoria has suggested that school organisation practices which allow students short periods of time on particular activities and with specialised teachers are not conducive to optimum learning (Hill & Russell, 1999). While Elmore, Peterson and McCarthey (1996) found some support in their research for the claim that standard ways of organising schools may limit teaching practice and undermine good teaching, they were unable to find evidence that changes in organisation lead directly to changes in teaching, and ultimately to improved student learning. They concluded that changing school structures may not lead to desired changes in teaching practice and that the transformation of teaching practice is fundamentally a problem of enhancing individual knowledge and skill, a focus which is reflected in the recent research of Rowe (2002). In support of their argument they report that some teachers were enthusiastic about new ways of teaching but lacked understanding of how to make them work with students, while others thought they were teaching in new ways, but seemed to be using only slight modifications of their usual practice.

Although the culture of the school appears rather predictable, at the micro-scale of the classroom teachers are known to be flexible in adapting to daily changes, leading Jackson, (1990) to call teaching an opportunistic process. Teachers learn to tolerate a high degree of uncertainly and ambiguity by establishing various frameworks, including the types of arrangements for students to learn individually and in groups, and expectations of the level of freedom allowed. Some research evidence shows a shift in the management and control of an activity from the teacher to the students and the

computer (Loveless et al., 2001). However according to Wenger (1998) there is a tension in this managing role as they frequently have to act as representatives of the school — as teachers — rather than as adults in a community of practice, and are thus unable to act as themselves and provide openings to the adult world.

The introduction of computers has drawn attention to both structure and opportunism. Research suggests that how the school organises the allocation of information technology resources and the culture in the classroom, including teacher attitudes and student interactions, is important in student learning (DETYA, 1999), while general classroom management has also been found to have a strong impact (Wang, Haertel, & Walberg, 1993). In most classrooms there will be fewer computers than students, so teachers manage student access in different ways, ranging from highly controlled to laissez-faire. Although many teachers strive for fair distribution of resources, the ways in which they organise classroom use can lead to inequities. The effects of gender, for example, are often overlooked, or subject to stereotypes. Teachers need to be aware that the way they manage the classroom environment and structure computer activities affects access, and therefore potential learning opportunities. Sanders and Stone (1986) suggested that teachers should actively manage to ensure that girls have good role models and access to computers. Dickson and Vereen (1984) reported that pairs of students on computers learn as much or more than individuals, and recommend that teachers manage pairing in school in ways that address the differential access student have to computers outside school. More recent research also indicates that girls use computers less often at home than boys (Carey, 2002; DETYA, 1999), with the accompanying suggestion that teachers need to redress this imbalance at school. These arguments are often conducted with the intent of encouraging more women into computer science courses and employment.

Teachers are frequently expected to motivate student learning, and in transmission-based classrooms they attempt to do so using a variety of methods, including competition, positive feedback and rewards including marks, free time, choice of activities or a prize and even tasks such as collecting books (Jackson, 1990). However self-motivated learning requires no bribes from teachers but depends on links to the world (Illich,

1971). The basis of intrinsic motivation for a student would therefore be having a purpose for engaging in an activity, and the role of teachers is to recognise how the students' experience can be further built upon and located in broader frameworks of knowledge (Selinger, 2001). The self-esteem generated by a sense of achievement should thus reduce dependence on extrinsic rewards in the knowledge-building classroom. Although teachers have sometimes used access to computers as a reward in the extrinsic sense, particularly where they have not integrated their use into daily classroom activities, real motivation is more likely to be linked to the ways in which they are used: for consumption, (re)production or creation. Papert (1991) in discussing the motivational and knowledge-building possibilities of *constructionism*—students making things —notes research evidence that indicates students are motivated by making, rather than merely using, software, in doing so they are able to concentrate their attention for surprisingly long periods.

The introduction of computers has created a new area of management in the classroom, as numerous issues of functionality arise with both hardware and software. Teachers using computers in the classroom frequently lack technical support, and are often less skilled in using the technology than the students they teach. Even where teachers have a positive attitude to innovation, the frequent technical difficulties encountered when using technology are very frustrating (Cuttance & Innovation and Best Practice Consortium, 2001). Drenoyianni and Selwood (1998) found that over eighty per cent of the problems primary teachers faced when using computers in their classrooms were of a technical nature. Because of these difficulties Preston (1998) found that teachers using computers in the United Kingdom saw themselves as *lion-tamers*, pretending control in classrooms with unpredictable computers, and coming to terms with constantly asking their pupils for assistance with these *lions*. This lack of skill is exacerbated where teachers have little opportunity to use or practise their own computer skills while in the classroom, because they focus on facilitating computer experiences for students (Evans-Andris, 1996).

Teaching and learning roles

When they are in a teaching role, as opposed to any other role in their life, teachers' primary expertise is in the area of learning, so that it is not surprising that the core of their work is teaching students how to learn (Laurillard, 2002). For this reason Pachler (2001) suggests that the potential and value of pedagogic mediation of teachers in the learning process makes school-based education vital. Selinger (2001) argues too, that the teacherless classroom is a myth. There have been suggestions that computers can perform a mediation role and the term *computer-mediated learning* is frequently used, although it often describes a transmission model. Without the input of a teacher, links between existing and new knowledge might not be made (Selinger, 2001). In collaborative computing environments, the communication patterns do not follow roles and status, but have been found to focus on joint goals and shared problem solving with spontaneous expertise from the teacher (Jarvela, Bonk, Lehtinen, & Lehti, 1999). Similarly in the constructivist classroom, Goodman and Goodman (1990) suggest that relationships between teachers and learners become characterised by trust and collaboration rather than conflict and domination.

The Vygotskian view places teachers in an important role in classroom interactions, whether using technology or not, although it may appear to be much more indirect than in the transmission model of teaching (Crook, 1994). The functions of mediation and scaffolding, including coaching and providing feedback, are fundamental to teachers' work. The mediator function, suggest Goble and Porter (1977), helps people to develop their ability to use new knowledge to change the pattern of their previously acquired knowledge, and for this to occur people need confidence, a realistic awareness of their own powers, and respect for the worth of others. They forecast the current shift in emphasis from the input of teaching to the outcomes of learning, suggesting that in order to mediate student learning teachers need to know about developmental stages, individuals' thinking processes and accessing resources, and to be concerned with teaching how knowledge can be sought, validated, assimilated and used as a basis for further learning. To be good mediators, teachers must make every effort to know and understand the learners. When mediating student learning, teachers constantly adjust the level of information and support according to students' needs, help them link new

information to prior knowledge, refine their problem-solving strategies, and learn how to learn (Jones et al., 1995).

The tools developed by Jungian psychologists have gained acceptance by educators as a framework for understanding individual differences. While teachers may not administer the tools themselves, the theory underpinning them is often referred to in planning learning activities and assessments. As teachers have become more aware of learning styles (Kolb, 1984b) or the multiple intelligences (Gardner, 1984) both of their students and themselves, they are also more able to identify the means to stimulate intellectual curiosity, which Dewey (1910) believed was a teacher's role. However the time required to know individual students is a concern. To address this, Jalongo (1991) suggests that meeting students' individual needs is as simple as providing a range of options for activities undertaken by students (the project approach). But she adds that coaching means that teachers become students of their students, noting how their purposes and techniques evolve and thinking about what would enable each child to move on to other levels or in other directions.

Scaffolding learning

Within the zone of proximal development, scaffolding is the term often used to describe the process of interaction whereby a teacher (or a peer) assists a student by controlling the elements of a task, which are beyond the capacity of the learner, until the learner is capable of doing it alone. This is not to say that isolated aspects of a task should be separated from the whole in a drill and practice manner, but it is the gradual removal of teacher control and support as the student gains control of the task. It can include teacher demonstration and modelling which can be imitated, so that as Vygotsky (1962) argues, instruction marches ahead of development, oriented toward the future, not the past. McKenzie (1999) describes scaffolding as providing structure — without which many students are unproductive — while maintaining initiative, motivation and resourcefulness. From an efficiency perspective, he suggests that scaffolding clarifies purpose and provides clear directions to the student, including assessment expectations, creates a pathway through material, reduces surprise and points students to worthwhile sources rather than unproductive ones. From McKenzie's description, it seems that the

act of scaffolding is generally in the hands of the teacher, and is likely to be interpreted in a range of ways.

Mercer and Fisher (1998) wonder if scaffolding is a particular type of teacher behaviour or a label that can be applied to any teacher intervention that leads to learning success for students. In other words, they ask whether scaffolding is a description of the intent or the outcome. They go on to suggest that without evidence of a learning outcome in terms of a specific skill, concept knowledge or understanding, the behaviour is merely help. From a teacher's point of view, it seems that various behaviours can be employed with the intention of scaffolding learning, even if in fact the learning outcome is not immediately evident.

If Vygotsky's zone of proximal development relates only to the individual, the theory places teachers in the important and somewhat difficult role of identifying the ZPD for individual students, and taking action to guide the student and provide opportunities for learning. Perhaps in order to make it easier for teachers, later authors have preferred to suggest that the ZPD should be seen as relating to a learning activity or event, rather than to an individual student (Lerman, 2001; Mercer & Fisher, 1998). Supportive teacher interventions, the style of classroom interaction, school culture and the mix of actors involved influence the potential for the learning activity. The limits of the ZPD on any task are therefore established in the course of the activity, by reference to past or current events, language or experiences, and through interactions between teachers and students or between peers. However Lerman believes that this is not to say that a ZPD can be created in every situation.

Sylva (1997) suggests that scaffolding is not a useful concept in classroom teaching, citing the research of Bliss, Askew and McRae (1996) who found almost no scaffolding in science classes in their sample of thirteen teachers. She argues that it is in one-to-one settings that scaffolding is more likely to be effective. However the concept of normal teaching in the twenty-first century is likely to be broader than she had in mind, and one-to-one interactions are frequent. But teachers are concerned that they lack sufficient time to scaffold learning for individual students in the zone of proximal development. For this

reason, Mercer and Fisher suggest that the ZPD is limited in its application to research on the quality of teaching and learning in classrooms. They suggest instead that the *community of enquiry* might be a more productive focus, whereby cooperative-learning groups can enhance opportunities for generative learning among individuals. Similarly, Tharp and Gallimore (1998) argue for both individual and cultural zones of proximal development, presumably a question of scale, so there can be a zone for any domain of skill in relation to an individual or a society.

Talk is a common form of scaffolding. Vygotsky (1962) held the view that people learn in dialogue with each other, and specified a form of dialogue between teacher and learner in which the learner constructs meaning in interaction with a teacher who supports and challenges, creating new perspectives leading to reflection on the process by the learner. This takes place in the zone of proximal development. For Palincsar (1986) dialogue is the means by which support is provided and adjusted, facilitating the collaboration necessary for the learner to acquire the desired cognitive strategies. She uses the term *reciprocal teaching* to describe a structured dialogue around reading texts using four strategies: summarizing, question generating, clarifying, and predicting. Each strategy is a means of aiding students to construct meaning from text as well as a means of monitoring their reading for understanding, while the longer-term goal is to help students become autonomous learners. The teacher and students take turns in leading the dialogue, with reciprocal interactions, while the teacher provides encouragement and prompts to create a system of temporary support that is adjustable for each student. This scaffolding is gradually dismantled as learners become more independent and create personal systems. Socratic questioning is another process of teaching through dialogue that uses questions to guide and nudge learners to the next step, through discussing facts and concepts, a rule or theory to account for these concepts and a method for deriving rules or theories in general (Brown & Palincsar, 1989).

Teachers have a hierarchy of goals and processes to develop students' thinking skills and to probe for understanding, seen by some as a critical means of providing support (Burbules, 1993). Conversation is sometimes seen as a separate form of talk. Baker, Jensen and Kolb (2002) make a distinction between dialogue and conversation,

suggesting that dialogue is the term used by epistemologically-oriented theorists who see talk as an intellectual process of refining knowledge. In contrast, conversation is the term used by those who focus more on human understanding and experience rather than abstract knowledge about ideas. They prefer conversation as a mode, because it values all participants' contributions equally. Likewise, Cherednichenko et al. (2001) prefer to use the term conversation, arguing that students engage in learning when they initiate conversations with teachers and peers, and subsequently produce and publish artefacts.

Within the learning space(s), whether face-to-face or electronic, teachers have a role to play in establishing a climate that is responsive and expressive and encourages thinking (McIntyre & O'Hair, 1996; Thompson & Zeuli, 1999). In recent years, educators have been encouraged to teach thinking skills explicitly to prepare learners for lifelong learning. A focus on problem-solving and critical-thinking skills means that teachers must provide students with opportunities to analyse, apply and evaluate information and must themselves be critical thinkers. This entails defining and clarifying issues, asking appropriate questions, judging the credibility of a source, solving problems and drawing conclusions. On the other hand, encouraging creative or divergent thinking can be more of a challenge to teachers, as the results can be unpredictable. In a *thoughtful classroom* (Russell, 2000), students have time to think, reflect and engage in sustained discussion, deliberation and inquiry, and use technology in ways that add to their thinking and learning approaches, making them more powerful. Teachers identify in advance the thinking and learning strategies, the dispositions, values, expectations, feelings, self-regulation and control they want the students to develop, then model them and show that they are themselves learners.

Monitoring and assessing learning

If students work on the computer for long periods of time, as Papert (1991) has noted, the timing of interventions is crucial. Mercer and Fisher (1998) found that in classrooms using computers the opportunity for teachers to make useful interventions varied with the nature of the software and the activities in which it was embedded. In observing and recording teacher-student interactions and analysing them using a neo-Vygotskian framework, they found that teachers could actively support student problem solving

without taking complete responsibility for it. They argue that further description and evaluation of the ways teachers attempt to scaffold student learning with computers should help teachers perform that role more effectively. The problem is not new. When an earlier form of technology, the language laboratory, was introduced, the teacher was expected to learn "an entirely new technique: he has to monitor" (Harding, 1967, p.117). It was suggested then that teachers could only focus on about five students for careful monitoring during each class, in order to offer detailed assistance. This suggests that teachers and students will need to discuss their expectations and negotiate the extent and type of assistance.

Other means of monitoring and scaffolding learning in the classroom, including non-verbal devices such as gesture, gaze and pause, are also important, and the increasing capacity for electronic communication is creating both new forms of dialogue and non-verbal cues. In describing schools as having the potential for knowledge building, Scardamalia and Bereiter (1999) note that asynchronous communication such as email has the advantage of allowing students to take time formulating a contribution, and reduces the barriers which prevent some from taking part in oral discussion. A record of exchanges can also be kept for reflection. While email is often used as a person-to-person medium, group communication can lead to further developments in knowledge building. Multimedia forms of representation can also be used in this process (McMahon & O'Neill, 1991).

The use of computers could lead to new forms of mediation, as they allow for new forms of teacher-student interaction. Research has shown that teachers continue to play an important part in establishing and monitoring learning in collaborative electronic environments. The process of knowledge building in collaborative learning involves mutual exploration of issues, mutual examination of arguments, agreements and disagreements, mutual questioning of positions, dynamic interaction and weaving of ideas. People engaged in online dialogue are able to cover most of these, but it seems there is a weakness in their ability to reach synthesis, according to Stahl (1999) who suggests six characteristics of quality in the knowledge-building process. They are brainstorming, articulating (explaining complex concepts), reacting (providing an

alternative perspective on a concept previously introduced by a student), organising thoughts so that a new perspective emerges, analysing views or data and generalising (extracting new information or knowledge that applies to a broader set of conditions). This requires more than simple discussion, but rather meta-communicative strategies that facilitate such collaborative dialogue. This means that someone must take responsibility for mediating.

One of the major sources of teacher power is in assessing student learning outcomes, whether of processes, cognitive and social outcomes or products. It is also an area of many difficulties, some of which are not recognised by teachers and students themselves. Teachers undertake most of the assessment and evaluation in classrooms, according to Jackson (1990), and in his observation and conversations, he found that teachers assessed student learning quite subjectively, being more concerned with enthusiasm and involvement than actual performance. He suggests that the communication of assessments applies to both social and academic behaviours and personal qualities and that because schools are reward-oriented, teachers today stress the positive aspects of behaviour and learning and tend to overlook the negative.

Assessment based on individual performance is most common, notwithstanding the social process encouraged in many classrooms. However, with the increasing use of technology to access information outside teachers' experience, Heppell (1993) suggests assessment by teachers is becoming even more problematic than before. On one hand the notion of self-paced, self-assessed learning is enhanced by the use of technology, and electronic storage of work samples and the development of digital portfolios provide new evidence for both formative and summative assessments. But in research-based work, establishing the source of material can be time-consuming, if not impossible, and even the quality of referenced material may be questionable. Assessment is also problematic when learners undertake authentic tasks with unknown solutions, as Carr, Jonassen, Litzinger, & Marra (1998) suggest. They argue that for constructivism to be successful, all members of the community are required to engage in social interaction, with educators sharing their power. Where students are encouraged to collaborate in this

way, the notion of assessing individual effort and contribution is difficult, and perhaps even unnecessary.

New roles for teachers

In *Deschooling Society*, Illich (1971) argued for opening up the market to *skill teachers,* people who form part of an opportunity web of resources including basic technologies, available to all who want to learn. This model could well be attractive in the twenty-first century, albeit for different reasons. In light of the growing complexity of teachers' roles, a projected worldwide shortage of teachers and the possibilities afforded by technology, some suggest that the roles described above will have to be distributed among many teachers rather than found in all individual teachers (Beare, 2001; Cohen, 1969; Cornu, 2001). A team of experts will undertake the work of teaching and the organisation of students into classes will be abandoned, suggests Beare (2002). As technologies spread throughout schools and systems, teachers will have opportunities for greater role differentiation and specialisation, some becoming instructional designers while others develop specialisations in assessment, small group facilitation or distance learning.

Hargreaves (1994) envisages a core of full-time, highly trained teachers supported by a range of assistants and part-time teachers who also cross employment boundaries to work in other fields. The spread of such *portfolio teachers*, modelled on Handy's portfolio worker, (Handy, 1989) allows a range of contract options, including the employment of experienced teachers who do not wish for full-time retirement. Beare suggests that all students will have one or more online educators whom they can access for consultation or advice about their learning programmes. This type of arrangement diminishes the importance of personal relationships between teachers and students, and could work against a sense of belonging. On the other hand, the collective intelligence (Levy, 1996) or collective competencies (Le Boterf, 2000) of the people in teaching positions will benefit the learners they interact with, while the collective efficiency of an organisation will depend on its ability to pool different kinds of knowledge and to manage what is distributed within the organisation and eventually beyond, in a network of organisations or of people. New individual and collective behaviours, including

crossing traditional boundaries, and exchanges that help develop collective competencies are therefore required (Amherdt, Dupuich-Rabasse, Emery, & Giauque, 2001, cited in Tremblay, 2002).

In this new society, both teachers and students will need new attitudes and behaviours. Renshaw (2002) links the current economic imperative for workers to be team players, self-regulating, flexible and predisposed to sharing expertise, with the emphasis on student collaboration in classrooms. He suggests that this emphasis creates challenges for both teachers and students, such as learning to listen and negotiate, engaging in exploratory talk and expressing tentativeness, courage to express ideas, persistence in problem-solving and generosity to acknowledge the good ideas of others. He also suggests that while teachers need to learn how to share power with students and trust them to be responsible, students need to learn a more active and collaborative role as authors as well as consumers of knowledge.

While teachers are said to be flexible in their daily responses to students, they are also at times reluctant to change, particularly in response to externally driven innovation. Nias (1987) believes that their apparent reluctance to alter classroom practice is due to a desire to preserve their sense of self. She assumes that teachers have an ethical right to determine the nature and the extent of the personal changes that they adopt, while also suggesting how they might be encouraged to do so. However she argues that many schemata are formed non-verbally and at a very early age, and can be very difficult to raise to the level of consciousness for reflection and discussion. She also suggests that since most of our perceptual habits are formed in childhood, learning is associated with dependency. Therefore situations that encourage adult learners to be authority-dependent make it difficult for them to accommodate new ways of thinking and behaving.

Teacher individualism and the need for identity also make it difficult to discuss disagreement and to develop a tradition of dialectic, thus denying a good opportunity for learning. Even where a team culture exists, when teachers focus on encouraging and supporting each other they sometimes avoid critique and challenge, which would assist in clarifying and improving their understandings. Hence Fullan (1993) calls for a

reculturing of school, to develop a school culture in which ongoing intellectual curiosity is encouraged for everyone. For the development of the profession as well as the individual, the traditional isolation of teachers will need to be replaced by teachers working together. A recent Australian report suggested that significant structural changes in education systems and in schools are required because the nature of the teaching profession as being practice *behind closed doors* mitigates moves to school-based collaborative teacher development (Department of Education Science and Training, 2001). As a first step, Boyle (1998) argues that a teacher as a colleague should be willing to open the classroom door in order to mentor others or to invite a mentor in. This is a challenge to the cultural norms of many schools, for neither their structure, the discourse of practice, nor the individualism of performance management procedures naturally encourages collaboration in daily work. A five-year Australian study using collaborative practitioner research in conjunction with university researchers identified a discursive environment, where teachers were able to talk about their actions and give reasons for unexpected occurrences (Cherednichenko et al., 2001). This environment also encouraged argument and critique. However the research also discovered an apparent lack of explicit and agreed language or discourse of learning for teachers to value and present their work, apart from the system-generated language of standards and outcomes.

Interdependence

A new approach to the culture of teaching includes moves towards interdependence rather than either dependence or independence. Perhaps the most challenging new role for teachers is working in real collaboration with other teachers, and taking responsibility for their learning (Venezky & Davis, 2001; Wade, 1987). Professional collaboration is a term increasingly used without being clearly defined, but generally appears to include teachers and administrators working together, sharing their knowledge, contributing ideas and developing plans for achieving educational and organisational goals. The notion of learning circles or professional learning teams has been promoted to facilitate planning and coordination of teaching programs and ongoing improvement of teaching and learning within the classroom (Hoban, 1997; Johnson & Scull, 1999). Where teachers reflect on and evaluate their practice together, as in these

teams, they are likely to be building knowledge in the organisation as well as developing individual skill (Hargreaves, 1999; Retallick, Cocklin, & Coombe, 1999; Senge, 1993).

In ideal communities people work together with common goals, take risks to explore areas outside their expertise and share their learning with other professionals, assisting each other to grow and develop (Jones et al., 1995). Teachers are as concerned with the progress of other teachers and the school as a whole as they are with their own success. However while they might plan, assess and reflect in teams, teachers who do not teach in teams ultimately determine their own classroom practices, allowing the structural isolation to continue. While the rhetoric of performance management encourages collegial interaction, team cohesion and modelling excellent teaching and learning skills (Department of Education Employment and Training, 2001), performance management systems tend to entrench individualism. Experienced teachers are expected to provide high-level professional assistance to other teachers in classroom related areas, but McGuinness (2003) notes that even for school leaders, the requirement to develop other teachers (in contrast to improving the whole school) is not a high priority among Victorian teachers. Yet others would argue that transformational leadership demands this behaviour (Leithwood, Jantzi, & Steinbach, 1999).

Teaching as a profession of knowledge builders

In this section, the focus is on teachers collaborating as learners with other teachers, rather than building knowledge with students in their classrooms. The concept of teachers as learners allows and encourages teachers to be active agents in their own learning processes, which lead to professional development and the creation of practical knowledge. Boyle & Skopp (1998) suggest that the dialectic between teaching as practice and as a profession can be usefully seen as an instance of Vygotsky's zone of proximal development (ZPD), in that it is the interaction between scientific, academic, or disciplined knowledge and the spontaneous knowledge of everyday experience (Vygotsky, 1962). Thus, each type of knowledge develops towards the other and, when they intertwine constructively, they create a rich base of knowledge that is both structured and grounded. Kolb (1984a) agrees that learning takes place in the zone of proximal development and argues for experiential learning, incorporating both active

experimentation and reflective observation. Honey and Mumford (1986) simplified Kolb's theory into a simple learning cycle incorporating four modes: experiencing, reflecting, theorising and implementing, and like Kolb, have devised tools for individuals to assess their dominant styles. This theory has been articulated in many individual and organisational development programs in Victoria in recent years, although it is not clear whether it also underpins their design.

While teachers focus on action (experiencing and implementing) in their practice, they have been less frequently involved in researching (reflecting on and theorising) this practice. Piaget (1969) expressed surprise that the large number of teachers did not produce a group of researchers among their ranks who focused on pedagogy as a discipline from the practitioner's point of view. Similarly the discourses of researchers and practitioners have often been separate. A constructivist approach to professional development values the experience and knowledge of practising teachers as a starting point and as a content base, and creates links between theory and practice. In acknowledging that professional development is becoming more constructivist, some argue for a closer look at the assumptions underlying new initiatives (Cochran-Smith & Lytle, 2001; Greene, 2001). Cochran-Smith and Lytle discuss three views of the relationship between knowledge and practice, which can influence professional development policy and programs. In the first, knowledge-for-practice, knowledge is generated by outside researchers and passed on to teachers to improve practice, while in the second, knowledge-in-practice, the focus is on practical knowledge generated by expert teachers for reflection by others. The third approach they call knowledge-of-practice, whereby teachers learn when they generate local knowledge of practice within the context of inquiry communities and connect it to larger social, cultural and political issues. They make a distinction between action research as a time-bounded project-focused approach, and their inquiry stance, which is a more fundamental way in which teachers, both experienced and inexperienced, work together to generate local knowledge, envision and theorise their practice, and interpret the theories and research of others.

Stance as a metaphor implies position, orientation and perspectives over time. The expert-novice distinction is irrelevant. Local knowledge, they say, is that which is integrated with daily life in schools and classrooms, and emphasises the link of knower to that which is known and the context in which it is known. Reflective practice serves to make connections between the daily work, its underlying assumptions and the agendas for school and social change. This approach has much to offer teachers integrating computers into their work, as it blurs the expert-novice boundaries, and links local knowledge and the broader social context. Where inquiry is a stance, say Cochran-Smith and Lytle, teachers and student teachers engage in joint construction of knowledge through conversation and other forms of collaborative analysis and interpretation, and professional development is linked to larger social and political goals.

Time

In a society where speedy, rather than thoughtful, responses are valued and outcomes are time-related, time is the resource which teachers crave. Teachers need opportunities for classroom experimentation and tinkering (Hargreaves, 1999) and time to share and discuss classroom events with other people, including researchers and other teachers, on an individual or group basis (Joyce & Showers, 1988). However lack of time, and the limited extent of teacher control of their time, have been suggested as barriers to collaboration and reflection, leading McLaughlin and Oberman (1996) to argue strongly for more discretionary time to allow for teacher research, team teaching and group meetings. Data from a survey of teachers in eighty-eight schools indicated that while teachers believed that collaboration was desirable, their actual circumstances, particularly lack of time, reduced collaboration, although teachers in middle-sized schools were likely to be more collaborative than those in small or large schools (Leonard, 2002). Culturally, the attitude that teachers are working only when in scheduled classes needs to be challenged, and time allocated for planning, reflecting, working with individual students and visiting other classes (Hord, 1997).

Attitudes to technology

Fear of technology *per se* is sometimes raised as an impediment to teachers using computers, but this fear is often grounded in practical concerns. Given time apart from their students, or computers on line at home (Preston, 2001) some teachers can build up

their experience and confidence, thus addressing their fears of using computers with classes (Cambre & Cook, 1985). A study of nearly six hundred elementary and secondary teachers in fifty-four schools showed that lack of experience with computers was one factor that led to resistance to technology (Rosen & Weil, 1995). Hannafin & Savenye (1993) identified several factors influencing teacher resistance to computers including the belief that computers do not improve learning outcomes, fear of losing control of the classroom, and fear of displaying a lack of knowledge or skill with computers. Rosen & Maguire (1990) suggest that although all people who use computers experience some anxiety or *computer phobia*, for teachers this anxiety interferes with their ability to integrate technology into the curriculum, thus affecting their students. However greater familiarity with computers and linking them with personal and professional purposes, coupled with encouraging teachers to learn together have been shown to be successful in addressing their fears (Hunt & Bohlin, 1985). The research of Cox, Preston and Cox (1999) highlighted the importance of perceived ease of use and pedagogical usefulness in the classroom on teachers' attitudes, rather than purely increasing their technical skills.

Differences in attitudes (of teachers and students) and pedagogy are sometimes attributed to gender (Ravitz et al., 2000), and in Liao's meta-analysis of 106 studies he concluded that males had more positive attitudes to computers, although he was not able to ascertain what factors might contribute to this (Liao, 1999). On the other hand, Mayer-Smith, Pedretti, & Woodrow (2000) found in their study of seven high-school science classes that student computer anxiety is not dependent on gender, and concluded that good teaching is gender-neutral. While this neutrality is unlikely, it may be that other variables such as years since initial training, access to learning opportunities and access to a personal computer could be important. Women tend to look for purpose in their use of the computer, rather than tinkering as men are said to do (Delaney & Dyson, 1998). In Finland a study found that middle-aged female teachers had lower technology skills than males, but they emphasised constructivist principles and were keen to learn more about technology to develop new pedagogical practices (Hakkarainen et al., 1999). Although the picture is not clear, both the ageing and feminisation of the teaching

profession in Australia will need to be taken into account when planning professional development.

Reflective practice in teacher learning

The concept of the reflective practitioner is based on integrating theory and practice, in that the investigation of practice, and the considered reflection on practice are the driving force for the generation of theory. It is therefore, an authentic practice for teachers to engage in. Dewey (1933) drew attention to the need to link the theory of reflection to the practices of teacher education, and the movement has gathered momentum in recent times. In most of the literature surveyed, reflection is closely linked with action. Dewey observed that reflective thinking involves a state of doubt in which thinking originates and an act of searching to resolve the doubt; it therefore looks both back and forward. He made a distinction between routine action and reflective action, suggesting that routine action is guided by factors such as tradition, habit and authority and by institutional definitions and expectations, and is therefore relatively static and unresponsive to changing priorities and circumstances. Reflective action, on the other hand, implies flexibility, rigorous analysis and social awareness. It involves a willingness to engage in constant self-appraisal and development. However in many western technological societies, in particular, the action mode appears to dominate the reflection mode (Kolb, 1984b) and in Victoria the demand to innovate often appears to be interpreted as a further call to action rather than reflection.

Schon (1983) describes two forms of reflection: reflection-in-action and reflection-on-action. Teachers often engage in the former as they act flexibly or think on their feet, but it is the latter — the systematic and deliberate thinking back over one's actions — which has been taken up by many designers of professional development programs for teachers. Baird (1991) advocates reflection as a means of progressing towards more purposeful teaching and meaningful learning, but he suggests that the term reflection is sometimes used in place of thinking. He asserts that reflection can be both introspective and outward looking, depending on the purpose and focus. A teacher might focus on specific personal performance or on his or her own learning abilities, or might explore the underlying meaning of a personal experience. Nias (1987) suggests that this type of

activity is successful when teachers join in on the understanding that the discussion of their own experience is valuable. However teachers who have often been passive receptors, rather than active creators, of professional knowledge are often unsure that they can learn from their peers, much less themselves.

Reflection can be anticipatory (occurring before the experience) contemporaneous with the experience or retrospective, according to Baird. Similarly, Lukinsky (1990) suggests reflective writing is useful before learning something new, while learning and after learning is completed. Reflective journals are used as a tool for connecting thought, feeling and action: the writing generates momentum and is the meaning, while the journal itself becomes an objectification of the inner search, and an anchor from which to make further explorations. Other forms of recording what is learned, such as audio and videotape, can be used, especially if they can be shared with other practitioners (Hogarty, Lang, & Kromrey, 2002). With regard to the online environment, Sorensen suggests that, contrary to the physical world in which action is seen to be primary to reflection, the virtual universe provides a context in which reflection may precede involvement (Sorensen, 1999). It is possible that for collaborative interaction and dialogue in online learning, the task of scaffolding learning processes that aim at supporting both interaction and (self)reflection must occur at a meta-level, in terms of creating awareness of the function of contributed comments in a dialogue (Sorensen & Takle, 2001).

In discussing reflective practice, Argyris and Schon (1974) also distinguish between two types of theories of personal action which teachers bring to their work: espoused theories and theories-in-use. Espoused theories exist at a conscious level, can be articulated and change with relative ease in response to new information and ideas. Teachers' responses to questions will indicate their conscious ideas, intentions and beliefs, perhaps influenced by policies from education systems, but, according to Osterman and Kottkamp (1993), these do not always guide teachers' behaviour. Argyris and Schon argue that theories-in-use are difficult to identify but more influential. Deeply ingrained, they are not easily articulated or changed. The concept of reflective practice maintains that teachers' theories-in-use are not changed by simply providing new information, but

through engaging observation and reflection to raise awareness of assumptions, behaviours and the impact of their actions.

In recent years studies have found that effective professional development includes aspects of reflective practice (Dexter et al., 1999; Dwyer, 1994), situated learning (Brown et al., 1989) and long-term collegial interaction (Joyce & Showers, 1988; Lieberman & Miller, 2001; Sandholtz, Ringstaff, & Dwyer, 1996). Other emerging themes include the importance of connecting teacher and student learning, encouraging the development of a common language and using structured tools and protocols to guide discussion (Lieberman & Miller, 2001). Darling-Hammond and McLaughlin (1996) suggest that effective professional development involves teachers both as teachers and learners, and allows them to struggle with the uncertainties that accompany each role. They also believe it must be experiential, grounded in inquiry, reflection and experimentation, collaborative, sustained and ongoing, and connected to their work, and other aspects of school change. The roles of learner and researcher are seen to be empowering as teachers reflect on experience, gather data and try new ways of working (Lang et al., 1995). This type of capacity-building professional development reflects the constructivist view of knowledge as constructed by and with practitioners, rather than conveyed by policy-makers in a top-down manner. Nias (1987) suggests that this type of activity is successful when teachers join on the understanding that the discussion of their own experience is valuable, but where they have been passive receptors rather than active creators of professional knowledge they are often unsure that they can learn from their peers. This is particularly likely to be so where purpose is lacking or unclear. For Loughran (1996) reflection is part of problem solving, being the deliberate and purposeful act of thinking to gain a better understanding of a situation or a problem, which leads to action. He suggests that the steps in the reflective cycle are suggestions, problem, hypothesis, reasoning and testing. Australian projects which encourage reflection among groups of teachers, such as the Project to Enhance Effective Learning (PEEL) (Baird & Northfield, 1992); and the Innovation and Best Practice Project (IBPP) (Cuttance & Innovation and Best Practice Consortium, 2001) suggest that teachers' professional roles are developing to include systematic research practices which enhance their own learning.

Reflection can take many forms and has many purposes, both individual and social. Zeichner and Liston (1996) consider five traditions of reflective teaching practice, the academic, social efficiency, developmentalist, social reconstructionist and generic. In the academic tradition, perhaps not surprisingly often found in the secondary school, teachers reflect about the content of the subject they teach. The social efficiency tradition, which emphasises external research as a basis for teaching expertise, encourages teachers to measure their own teaching against the knowledge base generated by research. In the third tradition, the developmentalist, the focus is on gaining greater knowledge of students' diverse backgrounds, understandings and developmental readiness for tasks through observation and reflection.

In contrast, reflection in the social reconstructionist tradition is a political act that either helps or hinders progress towards a more just and humane society (Freire, 1993; Kemmis, 1985). The emphasis is on thinking about issues of equity and social justice that arise in and out of the classroom and on connecting teachers' practice to social novice. He proposes that reflective practice includes a process of problem-solving, reconstruction of meaning and subsequent reflective judgements while persons are engaged in a significant new activity. He acknowledges that a current challenge is the identification of relevant theory and the creation and testing of interventions that can guide the development of reflection. Ball and Cohen (1999) suggest strategic documentation of practice, through artefacts, videos and teachers' notes that are then analysed, preferably with others. Using artefacts, they claim, helps avoid the exchange of buzzwords and slogans often found in professional conversations. However while these practices represent teachers' classroom activity, they can still allow teacher-student interaction to remain private and protected from the gaze of other teachers.

Conceptual framework of teacher roles

The literature reviewed above has considered current influences on roles and relationships in schools, particularly the social constructivist approach and the potential of technology to support knowledge creation. Viewed in conjunction with a pilot study undertaken in classrooms and described in Appendix 2, the literature points to three

broad elements of teachers' roles, which are broadly categorised for this study as designing learning environments, managing people and resources, and mediating student learning. The design of learning environments encompasses establishing the physical setting and the learning space as well as planning curriculum and resource use. This activity, which was both observed and discussed during the pilot study, creates a context and climate for building knowledge. Within this context, managing people and resources includes the new and extensive requirement of ensuring that the computers and peripherals are functioning, as well as organising students in groups and motivating and disciplining them. Classroom observation revealed many aspects of managing by teachers. Mediating learning includes the activities of instructing, demonstrating, coaching and scaffolding learning, as well as monitoring and assessing performance, as detailed in Appendix 2. A model was developed to show the interrelationships of these three roles with the intervening role, improving practice, as shown in Figure 2.1.

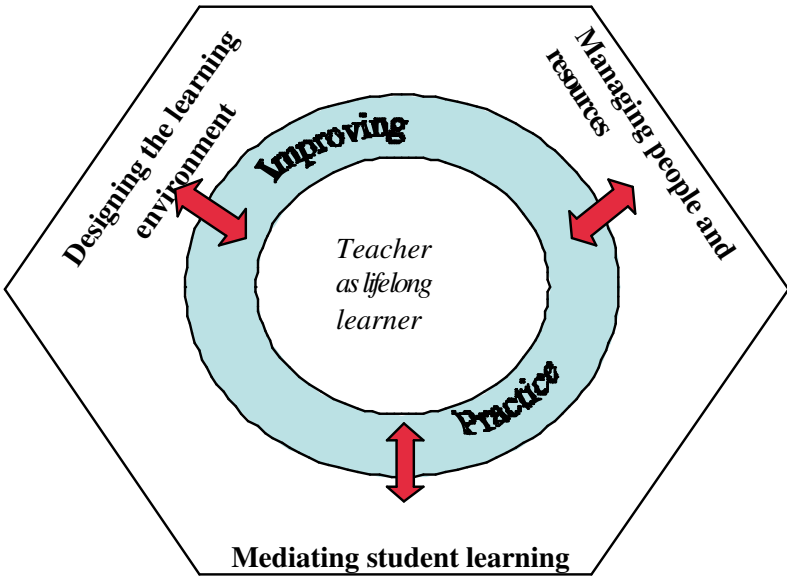

Figure 2.1 Model of teachers' classroom roles

As a model about teachers and teaching, Figure 2.1 places the teacher at the centre, acknowledging the expertise teachers bring to the classroom communities, while taking into account the need for lifelong learning on their part. The ring labelled *improving practice* links the teacher as learner with the substance of their classroom work. Both

discussions and observations during the pilot study indicated that teachers had a positive attitude to their own learning, and that the classroom was one site of this learning.

Some authors suggest that the future lies in separating the three substantive roles, so that individual teachers specialise in one, or aspects of one of designing, managing or mediating learning. Whatever the case, a socio-cultural approach to professional development encourages teachers to reflect on their practice and co-construct future scenarios. This study provides an opportunity for teachers to contribute to the discussion about future roles in a society where knowledge building is seen as imperative, and Chapter 3 describes the research design that allowed this to take place.

Chapter 3 : Research design and methodology

The literature reviewed in the previous chapter has described the current state of thinking and research in the areas of teachers' professional practice and professional development in a range of Western countries, particularly in light of the influences of social constructivism and technology. This chapter discusses the qualitative, ethnographic methodology chosen for this study. Its design is driven by a desire to offer practical research-based policy advice to schools and education systems grappling with the need to ensure that professional development and pre-service education of teachers supports student learning. It assumes that making explicit the knowledge of teachers' emerging practice, and giving voice to the perspectives of teachers in the field — particularly where they incorporate new technologies — will provide a sound basis for policy and practice.

Aims of the study

In order to answer the broad research question outlined in Chapter 1 — what are the characteristics of teachers' practice that enhance knowledge building in classrooms and across the teaching profession? — the following three questions are fundamental to the study:

- What current and emerging teacher roles are found in classrooms using computers?
- To what extent and under what conditions does knowledge building occur in each of these roles?
- What are the implications of the findings for teachers' professional learning and the development of new practices?

I reflected with teachers in Victoria, Australia over a period of three years to find answers to these questions.

The conceptual framework for the study

The model of teachers' roles derived from the literature and the pilot study (shown in Figure 2.1) was augmented by the addition of the infrastructures of engagement, imagination and alignment from Wenger's (1998) theory of communities of practice (Chapter 2, pp. 23-6). This resulted in the conceptual framework for this study shown in Figure 3.1.

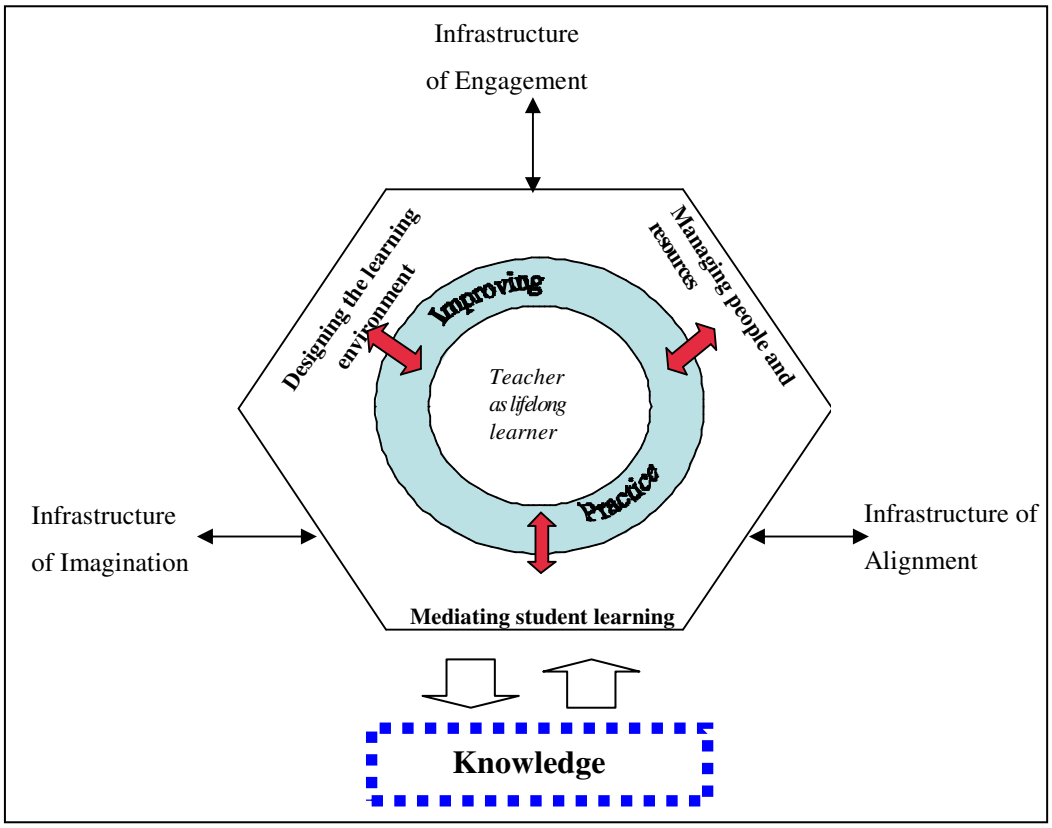

Figure 3.1 Conceptual framework for the study of teachers' roles in classroom communities of practice

This conceptual framework is based on a sociological understanding of relationships between people. The notion of community of practice, which in the first instance is based on the classroom, provides the hexagonal boundary within the model, and the actors are primarily teachers and students. The task of the community in this case is creating knowledge, where knowledge exists in society rather than in the mind (Scardamalia & Bereiter, 1999). In order to carry out the task, the members of the community engage in behaviours with subjective meaning, and these behaviours

constitute social action when an individual takes into account the behaviour of others (King, 1983). Therefore within the community of practice, individuals exist in relationship with others and in doing so play various roles in relation to others and to the task. However, since elaboration of role theory is not the purpose of this study, the use of the term *role* is designed to indicate the commonly understood classroom relationships of teachers with their students.

The three substantive teaching roles — *designing the learning environment, managing people and resources* and *mediating learning* — have separate characteristics although they are related. *Improving practice* is a role that crosses the other three. All roles are influenced by the three infrastructures of Wenger's learning architecture: engagement, imagination and alignment, and the relationships between teachers are expressed through these infrastructures, hence the thinner two-way arrows. I chose the hexagon to represent the boundary of the community of practice, such as the classroom, not only because it lends itself to accommodating the three roles on its faces, but also because it is a naturally occurring shape covering space. A single hexagon therefore encapsulates the classroom community, and in constellation with other hexagons shows how classroom communities can link with others in the institution, and on a broader scale, how school communities themselves can be part of a wider system.

Overall approach and rationale

The preferred approach for this research falls within the interpretive paradigm, which itself reflects the constructivist approach of today's classrooms, with a belief in a socially constructed, subjectively based reality. As a response to Selwyn (2000) who calls for more qualitative approaches to research into educational computing, the chosen design is ethnographic, based on what teachers and students are actually saying and doing in classrooms using computers. The society of the classroom is a rich context for learning, where teachers and students form a community of practice. The study is an attempt to record teachers' views of what they do and why they do it, to provide a mirror to assist their reflection and a means by which teachers can influence policy makers.

While a researcher is normally a visitor to this world, there is some benefit in bringing teachers and researchers closer, in an inside-outside model (Hoban, 1997) incorporating

reflection. Selwyn suggests rather disparagingly that research into educational computing is based on a particularly optimistic view of technology, yet this study is also optimistic in the sense that it is based on a view that teachers can act on and with technology, rather than being passive. Teachers are not merely subjects of the research, but partners in the process, and the resulting knowledge is the output of a collective enterprise, to be shared by participants (Freire, 1993; Thomas, 1993). Wenglinsky (2000) has argued that the classroom should be the focus of research into improving the quality of teaching, but it has often been neglected. Likewise, Jackson (1990) argued for a new look at teaching and learning by moving close to the complex phenomena of the teacher's world rather than relying on learning theory, which he believed to be too simplistic, or clinical psychology, which is a limited perspective focusing on pathology rather than normality. He suggested too, that more observational studies of classrooms, including the perspective of teachers and students, would lead to several critical perspectives rather than a unified theory of teaching, and to a shared language, which teachers and researchers can both use.

Ethnography

Ethnography, which grew out of anthropology and was taken up by sociologists, is the general study of cultures using observation, and the subsequent written account of those cultures, usually through close association of the researcher and the researched. Educational ethnography aims to provide rich descriptive data about the contexts, activities and beliefs of participants in educational settings, particularly concerning educational processes as they occur (Goetz & LeCompte, 1984). Ethnographic strategies elicit data that represent the world views of the participants involved, and they are empirical and naturalistic. Further, they are holistic, seeking to construct descriptions of total phenomena within their various contexts and to generate the interrelationships of causes and consequences that affect human behaviour and beliefs toward the phenomena.

Ethnography was a suitable choice for this study as it is open-ended and allows a variety of research techniques within the chosen cultures: communities of practice in schools with similarities and differences. The researcher provides both the mirror and the

microphone, engaging in reflection with the teachers and ensuring their thoughts and actions are documented. Goetz and LeCompte describe ethnographic research as rather generative, inductive, constructive and subjective in contrast to scientific methods. It is inductive in that starts from the examination of a phenomenon and develops a theory to explain what was studied, and generative in relation both to the position of evidence within the study and to the extent to which results may be generalised to other groups (Denzin, 1978). A constructive strategy aims to discover what constructs or categories can be found in the course of observation and description. There may be a balance between subjective and objective analysis. It is intended that this study should meet the criterion suggested by Goetz and LeCompte, who believe that an ethnographic product is evaluated to the extent that it describes the scene studied so that others can envision it in a similar way to the researcher. I believe it will be even more successful if participants can recognise the scene in a new light, so that

> … the end of all our exploring
> Will be to arrive where we started
> And know the place for the first time (Eliot, 1963, p.222).

A feature of this type of qualitative research is the absence of a strict theory or hypothesis on which to base the collection and analysis of data. It lends itself to the development of grounded theory, whereby theoretical understanding emerges from an iterative process based on constant sampling, comparison and analysis of transcribed excerpts (Strauss & Corbin, 1990). As the context of classrooms using computers is still relatively new, it was appealing to choose a methodology whereby modifications in both theory and design could legitimately be made during the study (Goetz & LeCompte, 1984).

On the other hand Hammersley (1990) laments the lack of development of theory in the sociology of education, suggesting that under the influence of symbolic interactionism, social phenomenology and ethnomethodology, research became mainly descriptive, with little explanation of patterns. He claims that interpretive ethnography is condemned to rely upon theoretical ideas that are vague and untested. He argues for research which clarifies variables and relations in regard to a particular theoretical idea, whereby given

certain conditions, if an event of a certain type (A) occurs, it will be accompanied or followed by an event of type B. Hammersley is looking for universal laws, which ethnography seems unable to deliver. Bassey (2001) addresses this problem in arguing that it is possible and useful to formulate the outcomes of empirical research as fuzzy generalisations: particular events may lead to particular consequences. This rethinking of the concept of generalisation allows for prediction based upon thick description, and holding as an aim the notion of what *could be* (in addition to *what is*). A study with the intention of providing advice to teachers, schools and systems should tackle the issue of what could be. The challenge in this study then, is to acknowledge the tacit constructs that underpin the research questions, provide rich description, and to reveal in the interpretation of the data the process through which tentative theories are developed.

A means of reflection

An important aspect of this study was the desire to participate with teachers in professional learning, not only to take information from them. As it was not based on an intervention *per se*, the act of reflecting was chosen to be the means of this joint learning. Underlying the reflection in this study is the notion of conversational constructivism, where reflection on personal experience becomes a learning opportunity and conversation itself is seen as a learning space (Baker et al., 2002). While there are some similarities with the action research model, which is intended to be collaborative and aimed at improving practices, understandings and situations (Kemmis, 1999), and is therefore a participatory form of professional development, this study, being owned by the researcher, is not action research. It does however value data collection and reflection and might encourage teachers to undertake their own research through treating their own ideas, theories, practices and work settings as objects for analysis and critique.

Reflection can assist teachers, both in their everyday practice and in better articulating personal theories (Griffiths & Tann, 1992). Table 3.1 shows five dimensions of reflection: the first two expanding Schon's reflection-in-action category and the latter three based on reflection-on-action (Zeichner & Liston, 1996). The first level, *rapid reflection*, describes the situation where a teacher reflects immediately and automatically while acting, while the second, *repair*, allows a quick pause for thought, such as reading

student reactions and making a choice of response based on previous experience. These two reflective practices can be observed in classrooms. This study aimed to encourage the processes of *review* and, to some extent, *research*, both prompted and documented by the researcher and through written reflective journals. The level of *retheorising and research* involving long-term reflection was a goal beyond the scope of this study, but as the relationship with certain participants developed it became evident.

Table 3.1 Types of reflection

Rapid reflection	Immediate and automatic reflection-in-action
Repair	Thoughtful reflection-in-action
Review	Less formal reflection-on-action at a particular point in time
Research	More systematic reflection-on-action over a period of time
Retheorising and research	Long term reflection-on-action informed by public academic theories

(source: Zeichner & Liston, 1996, p.47)

Through a process of guided reflection, teachers were encouraged to consider their classroom roles and their beliefs and understandings about teaching and learning, both for themselves and their students. I attempted to capture aspects of the richness and complexity of life in classrooms using computers, and to create meaning through making connections between observed events and teachers' statements.

The role of the researcher

My role is in this study was based on an ethical stance perceived to be of benefit to both participants and researcher, and a commitment to empowering teachers and practitioners, rather than using them as a passive resource. The research activity was designed to yield useful knowledge for practitioners and researchers, while the research process itself was intended to be a learning experience for all participants.

Beattie (1995) developed her ethnographic method of researching personal practical knowledge, derived from Connelly and Clandinin (1986), who describe it as an interest in understanding teaching acts in terms of personalised concrete accounts of people knowing. A researcher attempts to represent the participants' world views rather than a researcher's conceptualisation of the teachers' constructs. In the ideal form, the teacher is an active participant and co-researcher, working on the data with the researcher. Theory is not tested, but developed through the collaboration of teachers and researcher who

work together to reconstruct meaning (Connelly & Clandinin, 1986; Elbaz, 1983). Recognition and suspension of the researcher's cultural values and expectations are therefore of concern to the research. Denzin (1989) emphasised the positive aspect of holding up a social process for serious examination and confronting it in its own terms to isolate its key, essential features, and not classifying data according to preconceived categories but letting them arise from transcripts. However it is also important to take an active role as a researcher, to adopt a reflective attitude (Richardson, 1999). A constructionist approach to grounded theory is mirrored in the process by which theories are generated in the course of the interactions between researcher and data. Richardson suggests this broad approach to grounded theory recognises the constructed nature of participants' conceptions of particular phenomena and the interpretive nature of social research.

I was introduced to the teachers as a member of a team investigating the Successful Integration of Learning Technologies (SILT) in Victorian schools, and was not known to the students or teachers prior to the study. As the usefulness of the data is likely to be affected by the quality of relationships, I felt it was essential to spend time on developing trust with participants. Initially I attempted to establish a relationship whereby the teachers did not feel that their classroom practice was being assessed. The role I undertook in this study could have been described as observer-as-participant, whereby observation is the main focus, but some participation may occur. Since this can limit understanding, Walsh (1998) suggests that a preferred role is that of *marginal native*. At the beginning, the researcher is a stranger, but gradually becomes involved with the situation. The nature of a professional conversation with practitioners may even demand involvement, as the participants expect an educated response within the dialogue. Marginality maintains a balance between the strangeness that avoids over-rapport and the familiarity that grasps the perspectives of the people. Walsh suggests that this can cause a researcher considerable strain.

In light of the discussion above, the stance I took was influenced by prior views and experience. At once an academic researcher and a practitioner in the professional

development of teachers, formerly a teacher and school principal, I might have been seen by participants as both insider and outsider. Clearly the role was on the periphery (Wenger, 1998), and as the research progressed, it was played out in different ways with the various teachers and schools. I facilitated processes of reflection among the teacher participants and generally attempted to maintain a low level of involvement, but some teachers encouraged greater participation in data collection. However faithful the recording of statements and events, and the suspension of cultural values, my voice intruded by providing constructs for categorising and analysing the data and making decisions about what was important to report.

It is possible that a researcher, taking a critical approach, might assist in disseminating the teachers' voices, and this occurred in the latter stages, but this calls for caution, as the researcher's values form a lens through which the observations are gathered and the conversations conducted. As the professional relationship with teacher participants grew over the course of the study, and professional interaction and dialogue developed, it became apparent that my role as a researcher was akin to *participant learner*. I participated in the educational discourse, experienced the constraints of structure and organisation and shared the celebrations of collective knowledge building in the classrooms I visited. The students, the teachers and I were all learners in this endeavour, albeit with different purposes, but with mutual interests. A researcher as participant learner is therefore involved in situated, authentic, reflective and dialogic practice in a community of learners.

Participant selection

The research was conducted within the Successful Integration of Learning Technologies (SILT) Project in Victorian state schools, which commenced in 2000. Schools in three regions of the Department of Education, Employment and Training (Western Metropolitan, Barwon South Western and Southern Metropolitan Regions) nominated to participate, and representatives of the Department selected twenty-nine. In addition, all former Navigator Schools were invited to be involved. Two teachers from each school were initially designated to participate in the research. The shared characteristics of the teachers were that they taught in either of the Key Learning Areas of Science or Studies

of Society and the Environment (SOSE), in the middle years of schooling (Years 5-9: upper primary and lower secondary) and that they used computers in class from time to time. From this group teachers were invited to choose particular themes suggested by the researchers: in this case a study focusing on teacher roles and teacher learning. In order to ensure a varied sample covering both primary and secondary classrooms, I strongly encouraged some of the teachers to become involved. Apart from this, representativeness was not a requirement, as the focus was on finding a range of conditions in which any developing theory would operate, rather than generalisation of the findings across settings. Additional teachers and principals from SILT schools were invited in an opportunistic way to participate in the research because of their interest or experience, to support the development of theory (Miles & Huberman, 1994). Table 3.2 shows the characteristics of the participants, which teachers were asked to provide at the time of the first conversation.

Table 3.2 Characteristics of participating teachers

Teacher and School ID	Years teaching	Age range	Gender	School type
001 A	14	30-39	Male	Secondary SOSE
002 A	19	40-49	Male	Secondary Science
003 B	6	25-29	Male	Primary
004 C	9	30-39	Male	Primary
005 D	22	50-59	Male	Primary
006 D	21	40-49	Male	Primary
007 E	18	40-49	Female	Secondary SOSE
008 F	14	40-49	Female	Secondary SOSE
009 F	12	40-49	Female	Secondary Science
010 D	16	30-39	Female	Primary
011 F	15	30-39	Female	Secondary Science
012 C	3	25-29	Female	Primary
013 B	22	40-49	Female	Primary
014 F	24	40-49	Female	Secondary SOSE
015 G	11	30-39	Male	Secondary SOSE
016 G	10	30-39	Male	Secondary SOSE
017 F	20	40-49	Female	Secondary SOSE
018 H		40-49	Female	Primary
019 H	1	25-29	Male	Primary
020 H		50-59	Male	Primary
021 I	7	25-29	Female	Primary
022 I	6	30-39	Female	Primary
023 I		40-49	Female	Primary
024 J	21	40-49	Female	Primary
025 K	16	40-49	Female	Secondary SOSE
026 L	25	40-49	Female	Primary
027 L	1	25-29	Male	Primary
028 L	20	40-49	Female	Primary
029 L	17	40-49	Female	Primary
030 L	29	40-49	Male	Primary
031 L	29	50-59	Male	Primary
032 C	26	40-49	Male	Primary

In all, thirty-two teachers and principals contributed to this study in different ways. Twenty teachers (63%) were aged over forty, seven (22%)aged between thirty and forty, and only five (16%) — three males and two females — under thirty. Their teaching experience at the time the research began ranged from one year to almost thirty years. In comparison, according to the Department's payroll analysis, across the state in March 2000 the average age of teachers was 43.2 years, and 66% of all teachers were female.

The twelve schools comprised five secondary and five primary schools in the three regions, and two former Navigator Schools in the primary sector. All schools except E,

G and L were in the Melbourne metropolitan area. Teachers of Studies of Society and Environment (SOSE) predominated among the secondary teachers. In summary, as Table 3.3 shows, 32 teachers were involved, of whom eighteen (56%) were female, and fourteen male, with twenty-one (66%) from primary schools and eleven from secondary schools.

Table 3.3 Participants by gender and school type

	Primary	%	Secondary	%	Total	%
Male	10	31%	4	13%	14	44%
Female	11	35%	7	21%	18	56%
Total	21	66%	11	34%	32	100%

Informed consent was obtained from teachers and students (and their parents) in classes they nominated for observation (see Appendix 1: Approvals and Consent). After the first year, School D withdrew from the SILT Project and the three teachers took no further part in the study.

Data collection methods

The data collection methods were observation, conversation and document analysis (including curriculum documents, email messages and journals). Through a pilot study that I conducted in 2000 (found in Appendix 2), I established relationships with teachers in a range of schools, tested data collection methods and came to an understanding of teachers' broad classroom roles. The methods, and reasons for choosing them, are discussed in the following pages.

Observation

Observation is an important way to establish the current context of classrooms using computers. Without this, Cicourel (1964) argues that the correspondence between the hypothetical world, inferred from tools such as questionnaire items, and the actual behaviour, remains an open empirical problem. Osterman and Kottkamp (1993) argue that to facilitate reflective practice not only do espoused theories need to be described, but also a clear understanding of theories-in-use through observation is required. Therefore I undertook observations to provide evidence of classroom behaviour. Teachers were encouraged to invite me to attend a typical class using technology in the

Science or SOSE Key Learning Areas, but in some cases other classes such as Literacy, Maths or Health were observed. Classroom observations generally lasted the length of one lesson (40 minutes) in secondary schools or a session (2 hours) in primary schools. In all cases, the classrooms were either regular classrooms with from one to six computers, or labs with one computer per student.

Since classroom interaction between teachers and students was the focus of the observation, the work of Flanders (1970) was reviewed. He suggested that teacher behaviour consists of acts or patterns of acts that can be broken down into skills that form the basis for a training program. In addition he suggested that such interaction analysis could provide data for teacher self-development and behaviour change. His tools were not congruent with the holistic nature of this study, with its purpose to identify attitudes and actions in the classroom, rather than to challenge participants with discrepancies between attitude and actions. I anticipated that on their own initiative, teachers would reflect on any differences.

I observed classroom activity, made notes, sketched room layout and took photographs to build up a rich description. Many of the classes were accustomed to visitors and were full of activity and movement, so that I was able to blend in quite easily. The observation focused on the teacher's behaviour and I made notes of the teacher's interactions with the whole class, small groups and individuals, and the content of interactions. Flanders developed coding systems in advance of observations, but after some attempts to do this in the pilot study, this was abandoned in favour of writing longhand accounts with verbatim quotes wherever possible. Immediately following the observation the notes were written up as a summary and clarification sought from the teacher (by email) if necessary.

Teachers who have just left the classroom are often engaged in reflection-on-action, immediately re-constructing and reconstruing events and actions as a professional act (Schon, 1983). It was intended to capture this reflection where possible. For primary teachers this could occur at the end of the day if there were no other meetings, while for secondary teachers it was sometimes possible if they had a free period or other break.

However many teachers were so busy it was difficult for them to find time to reflect with me.

As Savenye and Robinson (1996) suggest, videotape can be a useful means of gathering data, so this was used to supplement written notes. In some classrooms I used a small, handheld digital video camera to record interactions between teacher and students. In these cases, samples of teacher behaviour, particularly in relation to the use of computers, were videotaped for up to ten minutes. The camera allowed for instant replay on its small screen and episodes were used for stimulated recall immediately after the observed class, when the teacher was able to review and comment on the tape, (after Mayer-Smith, Pedretti, & Woodrow, 2000; Osterman & Kottkamp, 1993). This enabled some reflection during a short audiotaped discussion with the teacher very soon after the lesson, to illuminate the behaviour and capture other comments. I also reviewed the videotape later and where useful, transcribed the tape for coding. Teachers were interested in reviewing their own behaviour and found that the video gave another window into student behaviour upon which they could reflect, as in this discussion:

> (Tape shows teacher in main classroom addressing the whole class)
> *Female teacher: Gee it's clear isn't it?*
> *Researcher: What were you doing there?*
> *Female teacher: I was obviously explaining they had their map and a lot of them were beginning to finish the mapping work so I was telling them to go on to the matrix 42 activities.*
> *Researcher: Then you were in the computer room.*
> (Tape shows male and female student working together on computer in pod, with male student nearby and teacher looking on*)*
> *Female teacher: He [student] knew the program very well, they had never done it before and he was actually telling them what to do. It was useful, interesting too, that I didn't know, she was doing all the typing and that's a problem: not having a computer in the room. Because I thought "G what are you doing?" He wasn't even moving the mouse. He was contributing but I thought she… and she's not usually a dominating type of girl. And [other male] was explaining what to do, because you can't actually have more than 20 words on a word search.*

In some cases it was difficult to collect good quality videotape because the intrusion of many voices in the classroom affected sound quality, and distortions from the computer screens affected picture quality. However photographs of the physical environment and student activities were taken at each school to supplement observation notes.

Conversation

In this study the use of the term *conversation*, rather than *interview,* is important as it is intended to signal an interactive relationship and a social constructivist approach to knowledge building. *Conversation* signifies the development of a creative or productive understanding rather than the transmission of pre-existing meanings from one person to another, and is used by writers who focus on human understanding and human experience rather than on abstract knowledge about ideas (Baker et al., 2002). It is therefore a suitable mode for this study, as it is a sign of the value placed on teachers' attitudes and experiences. Kvale (1996) argues that the research interview is a specific form of conversation where two people talk about a theme of mutual interest, and suggests that it is not very often that one person is interested in another's experience and views to this extent. It also acknowledges the importance of speech in making understanding explicit. From a Vygotskian perspective, teaching behaviour cannot be understood apart from the thought processes of the teacher, and in conversation with a researcher these thought processes can be revealed (Au, 1990). Similarly, a teacher's attitudes and feelings, and the reasons underpinning actions, are scarcely visible except through conversation, according to Jackson (1990), who points out the value in listening to both what the teacher is saying and how it is said, as well as considering what is not said. The epistemological view is that conversation is a social medium where knowledge is constructed (Cavazos & the members of WEST, 2001). In the course of a discussion with peers and with a researcher, teachers have an opportunity to verbalise thoughts that can be tested and refined in discourse with others. In contrast to an interview, conversation tends to be recursive rather than linear, as participants revisit previous ideas. Conversation may be the ultimate context within which knowledge is understood (Rorty, 1979, cited in Kvale, 1996, p.37).

I engaged in conversations with individual teachers and principals, and with small groups of from 1-4 teachers. While no interested teacher was prevented from being involved in the study, small groups were preferred in the conversation or group interview. Lofland and Lofland (1984) suggest that such interviews are beneficial because they can allow people more time to reflect, while one person's comments can encourage others to share opinions and ideas.

I outlined the issues for discussion via email several days in advance, and for the first conversation, covered beliefs about teaching and learning and attitudes to using technology in the classroom (see Appendix 3: Data Collection Tools, SILT Item 2). These were influenced by previous research and the literature reviewed in Chapter 2, including beliefs about student learning (Becker & Riel, 1999; Hill & Russell, 1999) and attitudes to using technology (Dwyer et al., 1991; Ravitz et al., 2000; Saye, 1998). In the second year the conversations tended to cover issues raised by the observations and teachers' current concerns, while in the third year the conversations focused on teachers' roles (see Appendix 3: Data Collection Tools, Conversation on teacher roles). This last conversation was influenced by the emerging data and the literature regarding changing roles (Baker et al., 1994; Crook, 1991; DEETYA, 1996; Dexter et al., 1999; Hadley & Sheingold, 1993; Kerr, 1991; Loveless et al., 2001). Most teachers therefore came to the conversation with some knowledge of what they wanted to say. The decision to prepare teachers for the conversation in this way was influenced by feminist researchers such as Oakley (1981) who suggest the interviewer should be open with participants about the purposes, processes and findings of the research, and it is consistent with the modelling of potential professional development practice. It is also sensitive to the time pressures on teachers. Participants were assured they were free to take the conversations into areas not listed in the email request.

Conversations were scheduled with participating teachers at a time to suit them, usually after school or at lunchtime. Some of the thirty-two teachers participated in only one conversation, while others were involved in several long and short conversation episodes. The location of the conversations ranged from a private staffroom or empty classroom to a public space in a school library or lunchroom. I attended each conversation, setting up the tape-recorder in the middle of the group. The aim was to play a low-key role to allow the participants to share ideas with each other, although not always profitably, as this unresolved exchange shows:

> *Teacher 011: But I find when I have got a bit of time at night and I can sit at home to use it, the school's Internet, the server will be down. It won't be answering, like three out of four times I won't be able to get on. So you think, why do you bother?*

Teacher 008: Well you get your own account, that's what you do. I've got my own account. You pay by the hour; it's cheaper to do it like that.
Teacher 011: But it's just totally unreliable that way. All weekend it wouldn't answer.
Teacher 008: No, it falls over, just get onto Netspace, it's fine.
Teacher 011: Then people have to use my other address.
Teacher 008: Well, they learn, how many do you email to?
Teacher 011: There's about 10 of us.
Teacher 008: Is that all? Set up a list then, set up your own list server. Get onto Netspace and have your own, if you set up a circle.
Teacher 011: Don't know how to do it.
Teacher 008: Well, do it. Learn how.
Teacher 011: (to researcher) So they are all the things that I just don't know.

This is not to say that disagreement should be avoided, as it can lead to new knowledge. In other cases, the conversation flowed between researcher and participants, with probes to gather rich data, and questions on specific issues raised during the course of the discussion. The frankness of the exchanges during conversations indicates that quite early in the study participants felt comfortable with me, and spoke openly.

Bearing in mind that sometimes teachers and external researchers engage in a one-way relationship described by Troyna and Foster (1988) and Kvale (1996) as asymmetrical, and to avoid appearing to be taking without giving in return, I gave an opinion or technical advice when asked by teachers. For example, I engaged in this exchange with a female teacher [008]:

Researcher: I can see you are a very active person. I am too. I've taught myself to reflect. I think that it might be useful for other teachers and also for you to articulate the issues because you are out front in terms of your use of technology.
Teacher: Yes and I've needed … and I'm always behind.
Researcher: Behind what?
Teacher: Letting kids know what's on next, what has to be done. I want parents to come. I am going to see a lot tomorrow night at parent-teacher night and they will be invited. It's good for them to come and see what their kids have done.

As the conversations were completed, the first tapes were transcribed to digital documents by an agency, but this was abandoned in favour of transcribing tapes myself, because as well as being more efficient it led to greater familiarity with the data and stimulated early analysis, as Lofland and Lofland (1984) suggest. Transcriptions were sent to the participants via email for further checking and reflection and to allow them to

build a type of reflective journal for further reflection in the future. While the Apple Classrooms of Tomorrow (ACOT) Project used audiotaped journals (Fisher et al., 1996) where teachers had freedom to report on what was most salient to them at the time, teachers in this study were encouraged to keep the conversation transcripts rather than the tapes for their personal use. Any notes I made during the interview were retained for cross checking with tapes to assist clarification of meaning.

Cicourel (1964) and Seale (1998) suggest the possibility of treating the interview as a social event in its own right, as a topic of observation. This was highlighted on several occasions, particularly where the group dynamics were revealed, and the extent of teacher collaboration became obvious in non-verbal ways. On one occasion two secondary teachers met with me for a conversation in a multi-campus school, after which one said it had been interesting because he and the other teacher *"never get the chance to talk about teaching: always about other things"*. Comments like this unconsciously reinforce the purpose and highlight the need for this research.

Reflective journals

In addition to the personal narratives built up through the conversations, teachers were encouraged, but not obliged, to write reflective journals. Writing is important in Vygotsky's view, as written speech is a self-reviewing structure of thought (Vygotsky, 1962) and as Jalongo (1991) argues, the stories of teachers recorded in this way are more than interesting anecdotes, but rather reflections of professional perspectives, priorities and practices.

During the course of the study, teachers in three schools kept written journals —in electronic form —for their own purposes, and most of these made them available to me. Some of the journals were structured around a set of questions devised in conjunction with a school-based collaborative project teachers were undertaking, while others were free-flowing. The requirements of the collaborative project mandated learning journals and they were written with the intention that the project coordinator and school principals would read them, rather than for the benefit of this study. While having a local audience placed some constraints on their content, it made the journals *authentic* in the

sense that they were part of the teachers' work rather than devised for the purposes of the research. Two teachers provided journals in the first year (2000) while eight did so in 2001, and five in 2002.

Policy and curriculum documents

I also asked teachers to provide any curriculum documents or lesson plans which would assist the research, while other relevant policy and planning documents were collected from the principals of participating schools and where possible, the schools' web sites. Planning documents collected included school-level planning matrices and documents explaining the curriculum planning process for teachers. Other curriculum documents included the CD-Rom and web versions of the Curriculum and Standards Frameworks (CSF II) and the charts supporting information and communications technologies in each Key Learning Area (Board of Studies, 2000). For each class observed I collected the current assignment sheet, assessment criteria or rubrics, and where instructions were written on the board, I photographed them. In two instances I collected school newsletters with reports from students about relevant class activities. The documents collected from each school differed in scope, depending on whether the school had actually produced particular curriculum or planning documents or on the extent to which they placed them on the Internet. Excerpts from the documents were digitised and included with the conversation transcripts.

Articles about teachers and schools in the study were collected from school, regional and statewide newsletters where known. For example, an article about the project involving two schools was published in Education Times, the Department's newspaper (Rennick, 2002), and one teacher had a short article published in a science teachers' publication. In some cases, with student consent, teachers gave me electronic examples of student products, and others were observed on school Intranet or Internet sites.

A two-hour interview was conducted in March 2002 with a staff member responsible for supporting learning technologies across the curriculum in the former Board of Studies, now the Victorian Curriculum and Assessment Authority. The purpose of this interview was to clarify the broad curriculum expectations at system level, particularly with regard

to student activities using technology, and to view support materials being prepared for teachers at that time. As researcher, I also attended an eLearning planning workshop run by the Department on 26 March 2002, where teachers were coached in writing a plan for a funding submission regarding information and communication technology, in particular for the construction of computer pods. Later that year I viewed a fifteen-minute videotape concerning the collaborative project undertaken by two schools in this study, made by the Department of Education and Training and presented in the television program Principals' Forum on 25 July 2002.

Email

Given the context of the study, and the fact that each teacher in the Department of Education and Training in Victoria has an email address provided through *edumail*, email was used to communicate with the participants. This proved to be problematic as some teachers found it difficult to access their email messages either due to lack of familiarity, lack of time, or malfunction of the system. Nevertheless, as email provides a record of communication in the way that a telephone call does not, I persevered with it, in addition to other forms of communication. Email messages were archived as documents containing potentially useful data, although in the first two years, little email contact occurred, except with three teachers. As this study was not an intervention, no email list was established for the purpose of communicating between the teachers in the various schools. However in the third year teachers and principals from two schools established their own email list and invited me to join, which I did. This enabled access to the public communication between sixteen teachers, and the possibility of responding. All email messages containing reflective comments were included in the data, while some purely procedural messages were not.

Data were collected over a period of two years from mid-2000, when the pilot study commenced, to mid 2002, taking in part of three school years, which have been designated Year One, Year Two and Year Three, as summarised in Table 3.4. The notes and transcripts of 25.5 hours of observation and 20.5 hours of conversation were supplemented with print and electronic documents. In all, over 100,000 words of conversation were transcribed and over 20,000 words of journal writing were provided

by teachers while observations, photographs, video clips and documents, both print and electronic, made up the data set.

Table 3.4 Forms of data collection

Year One	18 observations (13 hrs)
	6 conversations with 15 teachers (6.5 hrs): beliefs and understandings Informal contact at SILT seminars
	Documents Curriculum and lesson outlines Electronic journals from 2 teachers
Year Two	10 observations (8 hrs)
	9 conversations with 13 teachers (6.5 hrs): general Informal contact at SILT seminars
	Documents Curriculum and lesson outlines Student products (electronic) Newsletter articles Electronic journals from 8 teachers Email Videotape
Year Three	3 observations (4.5 hours)
	9 conversations with 11 teachers (7.5 hrs): general and/or teacher role Informal contact at meetings/workshop presentations Interview with DE&T
	Documents Electronic journals from 5 teachers Newsletter articles Email and distribution list messages Curriculum documents Videotape

Trustworthiness

If this study is to achieve the purpose of informing professional development, its findings must be seen to be trustworthy and therefore worth considering by policy makers. Schon (1991 suggests that both validity and utility are necessary aspects of rigour in a study of practice such as this. Rigour, says Schon, depends on the researcher's ability to generate, compare and discriminate among multiple representations of phenomena, while remembering that there is no absolute truth waiting to be uncovered.

Lincoln and Guba (1985) address trustworthiness by suggesting that credibility, transferability, dependability and confirmability are required from a study. First, they

suggest that in order to demonstrate truth value, the reconstructions that have been arrived at by the researcher should be credible to the constructors of the original multiple realities (the participants). Similarly, Walsh (1998) suggests participant validation as essential in ethnographic research, whereby the researcher shows findings to the participants for their agreement that this is what they say and do. While this can be problematic because of the potential for differential points of view, discourses and power relationships between participants and researchers, it was seen as essential for the development of shared knowledge in this study. Participants were encouraged to respond to the transcripts that were sent to them soon after each interview, and in a few cases participants responded by email with additional explanation or clarification. They were also invited to preview articles and conference papers as they were being prepared. Little feedback was received from teachers, but this cannot be construed as evidence that they agreed with all interpretations, as they were all very busy with other tasks. In most cases feedback indicated complete agreement, while in one case a participant sent a detailed email message in which he revised his thoughts.

Triangulation was also used, giving an opportunity to compare different kinds of data from different sources to see whether they corroborate each other. In this study journals and observations were such a source, as they could be compared with conversation transcripts for particular teachers. The journals were more regular than the conversations and provided more information, written in the course of teachers' practice and shared in chunks of at least a term's worth of writing. They built up a picture of classroom life, especially when coupled with the oral reflections of the participants. However they were taken more on face value than as tests of validity.

In terms of transferability, Lincoln and Guba suggest that it is contextual similarity that makes one set of findings appropriate to another setting, and that the responsibility of the original researcher is to provide sufficient descriptive data to make such judgements possible by others. Although the participants all came from a similar broad context—state schools in Victoria —I deemed it necessary to gather rich descriptions of their particular settings, through text and images, to allow for such applicability. My previous

extensive experience in this context was also brought to bear on the descriptions in this study.

Lincoln and Guba suggest that both dependability and confirmability can be achieved through accurate audit trails of the products generated throughout the research. A large amount of electronic material was filed by date and participant (or school), in order to allow for simple retrieval.[1] The categories of description, developed on the QSR N4 Classic software (Richards, 2000), can be traced over time, although they are my own constructions and others might arrive at different categorisations of the same data. With this in mind it must be remembered that the analysis and discussion of findings reflect a personal view, but one that is acknowledged and documented throughout.

Data analysis

The nature of the research questions, particularly the focus on identifying new and emerging roles that assist knowledge building, demanded detailed analysis of all available data. In the first instance all documents were coded in a simple frame based on the conversation prompts and the teacher roles identified in the pilot study, using QSR N4 Classic software (Richards, 2000). Simple text searches enabled a broad picture of the cohort to be established, while the coding categories allowed for comparisons to be made between teachers and schools based on the demographic data, particularly gender and school type. Categories were also developed to cover the physical environment (classroom, pod or computer lab) and the types of student activities (consumption, reproduction or creation). Examples of individual and collaborative practice for both students and teachers were classified. Samples of the developing coding categories are found in Appendix 4: Notes on Data Analysis.

The software enable me to generate numerous reports, based on simple coding categories or a cross-tab approach, in an attempt to identify patterns in the data. On

[1] The original tapes and electronic transcripts are held in the Centre for Applied Educational Research at The University of Melbourne.

many occasions the data samples were referred back to their context — the original document — to assist interpretation. Although conversation was the form of much of the data, the method of conversation analysis (Sacks, 1992) was not used because the form and procedures of conversation as interaction were not the focus of this study. However as Lofland and Lofland (1984) suggest, the data were also analysed to identify instances where topics raised by some teachers were evaded or ignored by others, as these can also be important. The transcripts were then considered holistically and annotated (as in Appendix 2) to identify any new dimensions.

The development of propositions

Bassey (2001) argues that a study such as this with the intention of providing advice to teachers, schools and systems should tackle the issue of what *could be*. For this reason it was important to capture singularities or single instances, because if an occurrence supporting knowledge building is found in one setting, it might be able to be implemented elsewhere. As the study proceeded, and particularly as I reviewed and reflected upon conversations and observations, it became evident that while all teachers played the four roles to varying extents, they displayed characteristics across a continuum from facilitating to knowledge building, and that the gap between the facilitators and the expectations set by knowledge builders constituted a zone of proximal development (ZPD), in Vygotsky's terms. The analysis proceeded with a return to the original transcripts, using Microsoft Word to perform simple text searches situating coded comments in context, and the development of a series of propositions based on the data. These propositions clearly did not all apply to all teachers and schools participating in the study, but there were instances of each one occurring to varying degrees, and in a few cases, many of the propositions applied. The guidelines for including a proposition were based on at least one instance in the data — a singularity (Bassey, 2001) — with supporting or explicating literature. In the case of several propositions, there appeared to be contradictions between the views of the teachers quoted, but these were not generally offered as a dialectic or alternative positions fervently held, but rather as points along a continuum of development. This is an interpretation that might, of course, be challenged from a more critical standpoint. As

the propositions relating to each role were developed, clear themes became obvious in terms of teacher beliefs, open-endedness, or collaboration with technology, for example. Continuing contact with several of the teachers through the SILT Project and in other forums provided an opportunity to hear them reflect on and discuss their practice, while I conducted further searches of the literature for research evidence which might support the propositions. In this way the propositions that were grounded in the data could be situated in the broader context of teaching and learning based in the literature. This then provided the structure for the four chapters of findings. While the findings are intended to show practices that enhance knowledge building, they are tested only against the literature and through teacher feedback: that is, given the definition adopted by this study, and what we already know, they are thought *likely to* enhance knowledge building.

Having thoroughly combed the data and developed propositions regarding each of the four roles in the model, illustrative quotes from the text and images of classrooms were selected from the many available. Since I felt that the insightful words of any one participant could illuminate the future, there was no intention to provide a balanced coverage in terms of teacher or school representation, but to show examples of themes emerging in teachers' roles. Quotes were selected on the basis of their clarity, representativeness of a position in the literature, representativeness of observed school culture, and in some cases, uniqueness of thought or action. Since the tools of conversation analysis were not required in this study, and oral language was to be presented in written form, many quotes were edited to improve grammar and syntax in order to clarify teachers' meanings. To make each chapter manageable, many quotes and images were not included. Data presented in each chapter were labelled by school type, gender and assigned identification number to maintain anonymity. A table indicating the number of quotations from each teacher is found in Appendix 4: Notes on Data Analysis.

In the final phase, the findings were considered as aspects of a community of practice (where the practice is building knowledge). The theoretical framework developed by Wenger (1998) incorporates coverage of the facilities of engagement, imagination and

alignment. This provided a way forward to describe the characteristics of knowledge-building teachers and their communities of practice and, where the data made this possible, to make explicit how they had come to achieve this. This forms the bulk of the final chapter and is designed to support the policy advice for professional development for teachers.

Leaving the field

As a final recursive step in the study, the findings were reworded as a two-page framework (or map) for teachers to reflect on their own knowledge-building behaviours in a community of practice. All thirty-two teachers involved in this study were sent the document with a covering letter, indicating that it was created from my analysis of their conversations and other data, as a means of reporting back to participants. The document (as found in Appendix 5) was emailed to teachers who had shown that they used this form of communication readily, and posted to the rest in December 2002, and all were invited to respond. Fifteen did so almost immediately, indicating that it could prove to be a useful tool. Chapter 8 further discusses the document and its potential use.

Limitations of the research design

Conducting the research within the SILT Project afforded both opportunities and constraints. At a broad scale, it placed the study in a national funding context and provided a partner (the Department of Education and Training) with system-wide resources and consequent expectations, and facilitated access to existing system and school-based knowledge. In the changing context of research training, the funding partner's expectation of speedy and utilitarian outcomes from the study was a challenge and at times, a burden. At a smaller scale, although the schools and teachers participating in the SILT Project were seen to be successfully integrating technology, some of them had made little progress. They had been selected without reference to the topic of this study, and it was evident, particularly at the outset, that the interests of many in SILT schools could be described as quite altruistic and student-oriented rather than self-reflective and concerned about teacher learning. On the other hand, the relative open-endedness and non-interventionist nature of the SILT Project gave few guidelines for teachers, and meant that teachers' behaviours were more likely to be natural, rather

than contrived for the benefit of a researcher. As the relationship developed this aspect was seen as a benefit for the study.

The conceptual model was refined on many occasions, as might be expected of this type of research. The model as it currently appears was developed through close observation of, and reflection on, teachers' practices, in the context of the social theory of communities of practice (Wenger, 1998). While there are other ways to view the context, such as through the lens of teacher competency and performance, or from a critical ethnography stance, the choice of model and approach was appropriate in terms of the literature underpinning this study and my prior views.

The study is generalisable to the extent that teachers raised similar issues across a range of settings, but as the classes involved were mainly in Science and Studies of the Society and Environment (SOSE) they do not form a complete picture of teacher practice. Particularly in primary schools, these areas are treated quite differently from literacy and numeracy. The middle years (upper primary and lower secondary) covered by the study are also likely to be treated differently from senior secondary and to a certain extent, lower primary. However these are important years in terms of maintaining student interest and engagement, and are the focus of concern for the Department of Education and Training in Victoria at present. Student voice is deliberately not included in this study except on a few occasions, because its focus is quite clearly on teachers' roles in knowledge building.

Although comprehensive, the data collection methods were relatively unstructured, resulting in large amounts of seemingly disconnected data from the various teachers and schools. It might have been more straightforward to structure the conversations, although this could have reduced the range of perspectives. Teachers were genuinely cooperative, but the aspect of reflection was not developed as well as I had hoped, as it was often hard to find time for relaxed, free-ranging conversations in schools, where social and professional discourse was frequently interrupted by pressing events. Email was used less than expected. The documents (print and electronic) available in each school varied markedly, a fact that underlines the differential implementation of

knowledge management in schools. However once the frame of teacher roles was developed through the pilot study it became relatively simple to code and categorise the data with the QSR N4 Classic software (Richards, 2000), although in order to maintain a holistic view, the original tapes, transcripts and other documents were frequently reconsidered. Many of the features of the software were not used in this case.

This chapter has established the parameters of the research, and discussed and justified the choice of particular ethnographic methods: classroom observation, conversation, written reflection and document analysis. In the following four chapters I present the findings of the study based on the four roles of teachers in the conceptual framework. Chapter 4 considers in detail teachers' roles in designing the learning environment, Chapter 5 considers managing people and resources, and Chapter 6, mediating student learning. These three roles are all influenced by the fourth, improving practice, which is considered in Chapter 7. In the final chapter I draw these elements of teachers' roles together, to provide a comprehensive framework for knowledge building, analyse them once more in terms of Wenger's (1998) theory, and discuss the implications of the study for theory and practice.

Chapter 4 : Designing a learning environment for knowledge building

This chapter examines the first of the four classroom roles of teachers identified in Chapter 2: designing the learning environment. The role of designer is a planning role with regard to both the curriculum and the physical environment. In Figure 4.1 the focus is on this role in relation to the classroom, with minimal reference to managing people and resources (M) and mediating student learning (ML).

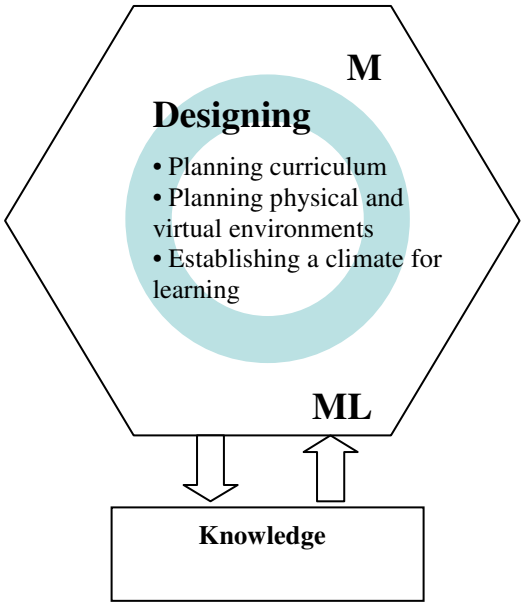

Figure 4.1 Designing the learning environment

The literature reviewed in Chapter 2 showed that design can be seen as a problem-solving process played out in the context of teachers' beliefs and understandings and their theories of learning (Fraser & Spiller, 2001). Further, as facilitators, teachers set the mood or climate of the class, clarify purpose for individuals and the group, and make a wide range of resources available (Rogers, 1969). While some believe that curriculum frameworks and outcomes controlled by education systems give teachers little scope for creativity (Cuban, 1984; De Marrais & LeCompte, 1999), others see them as providing a structure which can be filled with a wide range of learning activities devised by teachers and students (Scardamalia & Bereiter, 1999). The constructivist classroom, with its

emphasis on open-endedness, requires a wide range of resources with the potential to flesh out the apparently empty framework, and demands a great deal of the teacher (Cuttance & Innovation and Best Practice Consortium, 2001; Zucchermaglio, 1992). Technology provides opportunities to design in new ways and for new configurations when teachers are aware of its potential to support the learning activities (Loveless et al., 2001) such as connecting with experts (Brown & Campione, 1994), creating context-specific resources (Reid, 2002), and collaborating with other learners, both locally and internationally. The physical environment is thought to impact on behaviour and learning, so classroom layouts are an important consideration, which can be influenced by teachers and students to varying extents (Fisher, 2001; Nias, 1987; PricewaterhouseCoopers, 2001). Changes envisaged for school environments include more open-plan designs and flexible scheduling (Beare, 1998; Heppell, 1993; Salisbury, 1996).

The evidence of teachers' designing role was taken from documents, conversations and observation of the physical environment in which they work, as outlined in Chapter 3, and the outcomes of curriculum design activities were seen in the classrooms through student behaviours and products presented during observations or sent to me electronically. As the focus of the study was in the Key Learning Areas of Study of Society and Environment (SOSE) and Science, these are the areas covered in the secondary school data, while all the primary school data refer to Integrated Studies. Within the designing role, the data were considered in terms of the extent to which they represented a knowledge-building culture among teachers and students, leading to a set of propositions regarding teachers engaged in knowledge building. This is not to say that all teachers in the study displayed all the behaviours or beliefs, but that they were evident to varying extents among the participants. The nine propositions are presented as numbered headings, forming the structure of this chapter, while teachers are identified by gender, school type and identification number.

4.1 Teachers' understandings about student learning inform design

Teachers have been exposed to a limited range of post-behaviourist learning theories in recent years, and particularly with the drive for school reform (Hill & Russell, 1999),

coupled with the advent of computers, have been encouraged to clarify their own philosophical base and theories of learning (McKenzie, 1998). Cognitive psychologists have encouraged them to understand the individual learning styles of students (Gardner, 1984, 1999; Kolb, 1984a) while social constructivists have promoted a view of the classroom as a mini-society engaged in activity, discourse and reflection (Vygotsky, 1978).

Current approaches place the emphasis on a student-centred classroom. When discussing their role in setting directions for learning, teachers in both primary and secondary schools in this study readily incorporated elements of constructivism and its consequences for the teacher's role as a facilitator into their discourse:

> *I think that's the thing that we have developed very well in the school: that the teachers have taken on that role as a guide and a facilitator (female, primary principal).* [023]

> *Facilitating, making sure that they're going in the right direction, but they're the ones moving, you're not the one moving them (male, primary teacher).* [019]

However this was not a universal culture, and as Becker and Riel (1999) found, even a teacher who holds strongly constructivist views can find it difficult to implement them, as this teacher suggested:

> *But it's probably still the case that the students expect you — you are the teacher — to deliver the curriculum (female, secondary teacher).* [007]

Teachers in this study were generally able to influence design at the classroom scale, both in the short and long term, and some, particularly in the former Navigator schools, articulated an underpinning theory. Cognitive processing theory influenced the choice of imagery around the walls of the primary classroom in Figure 4.2 (school B), while the sense of a community of practice is promoted by the teacher in the suspended sign — *Heart of the Room 8 Learning Community* — from which heart shapes hang, designed to remind students about the important skills of helping, celebrating, learning, supporting, listening, respecting and negotiating with each other. The furniture is arranged in clusters, and the six computers are distributed within the clusters.

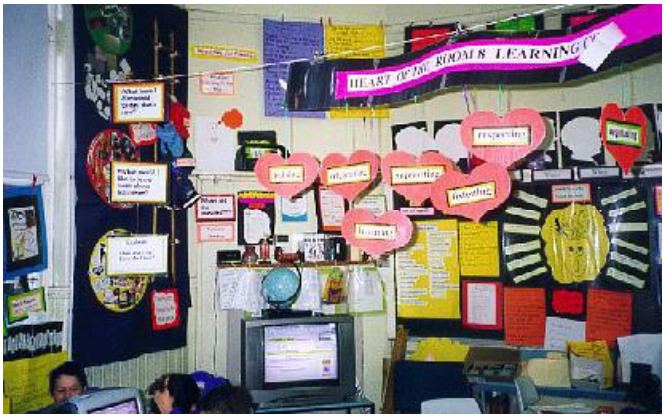

Figure 4.2 Learning theory display in primary classroom (school B)

The classroom in Figure 4.2 is typical of the primary classrooms observed, in its use of vertical and horizontal space. The walls are covered with colourful posters about learning and thinking, multiple intelligences, project steps and questions students should remember to ask themselves about their work, such as *"what have I discovered today that's new"* and *"what would I like to learn more about tomorrow?*" The teacher and students display a sense of ownership and shared discourse.

Teachers also referred to individual differences in cognitive styles in discussing various aspects of design, including the physical environment, as in these two primary schools:

> *You'll probably find that in most classrooms there is not a table and chair for everyone to sit down at the same time. Because we've talked about the validity of all kids doing the same thing at the same time and if you take into account people's learning styles and multiple intelligences, how can you validly then sit them all down and have a lesson for the whole class? (female, primary principal).* [023]

> *And we were hard against it in rooms like this, trying to have a quiet area for the kids who like silence and [another for] the kids who like a bit of music…and that's just the simple geographical thing that we need to be aware of in terms of providing appropriate learning situations (female, primary teacher).* [013]

Some showed an awareness that understanding individual differences also refers to students' cultures, prior experiences, languages, and (dis)abilities, as these two secondary teachers reflected:

> *This is a very multicultural school; there are many kids here who haven't had schooling until they come to Australia. For them technology is extraordinarily powerful because it shows them a window on the world that they've never seen. However it does bring up all kinds of issues at this school as they realise all of a sudden that their own countries don't have this kind of technology (female, secondary teacher).* [025]

> *Catering for individual needs, I think I'm quite good at dealing with the students who are middle and above. I haven't got a problem with that, but the weaker kids, that's where it becomes really awkward and hard, to get the time to prepare work. We had a number of integration students, they're always the most challenging, because they require such an alteration to the curriculum, that it's just really time-consuming and hard to do (male, secondary teacher).* [016]

Many teachers have incorporated the notion of a scaffolding structure into their theory of learning, reflecting Vygotsky's (1978) concept of a zone of proximal development (ZPD) which one primary teacher referred to in these terms:

> *If the activity's engaging enough, if it's open ended enough, if it's not beyond the children's level. If it's too far, too high or too low, it's not going turn them on to learning. If it's somewhere in between there's a very good chance the kids will learn (male, primary teacher).* [004]

Both primary and secondary teachers referred to elements of structure in their personal theories:

> *If it's open ended, some students will just not get there and if it has that element of structure, for some kids, it provides a bit of a security blanket and a safeguard that they can use (female, primary teacher).* [012]

> *It's more putting structures in place early that can be built upon and developed in the hope that they get a bit more mature, physically and emotionally. But those things can be built upon and then they become a full operating autonomous learner (female, secondary teacher).* [007]

However others had developed pragmatic responses to these theories that address individual styles in different ways, as these two secondary teachers explained:

> *I don't look at individual students as such, I just think, "well I can't provide 25 different ways of learning. That's not within my*

> *capability, I'm not even going to try". So I will provide a number of ways in the hope that that will catch 23 or 24 of them, somehow (female, secondary teacher).* [008]
>
> *Rather than saying, this kid's a type of this, this kid's a type of that, I think you have got to try and balance those things up and take that into consideration in planning any activity and you try and do that as much as possible, using the constraints that you have (male, secondary teacher).* [001]

Awareness of, and belief in, particular learning approaches can assist teachers to argue for particular design modifications. Where teachers valued collaborative approaches, they experimented with various configurations of classroom furniture to encourage joint tasks. Figure 4.3 shows a computer lab in school F, where computers are placed on the perimeter walls; but unlike many labs observed, it includes a central space with tables around which students can discuss and collaborate on tasks. The teacher pictured has influenced the layout of such rooms over several years to support a social constructivist approach.

Figure 4.3 Design for collaboration in a computer lab (school F)

In other schools, examples of classroom layout considered less likely to encourage collaborative knowledge building included student desks in rows facing a board, and labs where computers were crowded, allowing little room for other activities. In these cases, espoused learning theory was sometimes overwhelmed by physical constraints, or social constructivism was not a strongly-held belief.

4.2 Teachers incorporate, but are not bound by, curriculum frameworks documents

Petraglia (1998a) champions open-endedness, arguing that if the learner is to think in the knowledge domain as an expert user of that domain might think, limits on content deny possibilities of knowledge creation. For about twenty years in the latter part of the twentieth century, schools in Victoria had no mandated statewide content, and curriculum development was the responsibility of individual schools. Currently, the statewide Curriculum and Standards Framework (CSF II) contains desired outcomes and suggested content in all Key Learning Areas across six levels from Preparatory to Year 10 (Board of Studies, 2000). This document points out that students will undertake a wide variety of learning activities and tasks, and that the indicators do not prescribe or limit this range or determine how teachers will assess. The Department of Education and Training provides supporting resources for teachers in print form, on its web portal (SOFWeb), and on CD-Rom.

As the study reported here focuses on the Key Learning Areas of Study of Society and Environment (SOSE) and Science classrooms, the broad types of learning technology activities suggested by the Department in these areas are shown in Table 4.1. It can be seen that these activities cover the range from consumption (accessing, downloading, selecting) to creation (programming, creating) as outlined in Chapter 2, and allow for a variety of content.

Table 4.1 Student activities suggested in Curriculum Standards Frameworks II

File Management	**Word Processing**	**Graphics**	**Multimedia**	**Electronic Communication**
Retrieving	*Keying*	*Drawing*	*Accessing*	*Retrieving*
Saving	*Editing*	*Painting*	*Creating*	*Creating*
Storing	*Printing*	*Selecting*	*Integrating*	*Uploading*
Organising	*Formatting*	*Importing*	*Linking*	*Linking*
	Importing	*Editing*	*Presenting*	*Downloading*

Data Logging	**Database**	**Spreadsheet**	**Desktop Publishing**
Observing	*Accessing*	*Creating*	*Creating text*
Measuring	*Editing*	*Calculating*	*Creating graphics*
Manipulating	*Sorting*	*Analysing*	*Designing layout*
Exporting	*Structuring*	*Charting*	*Importing data*
Analysing	*Reporting*	*Programming*	

(source: Board of Studies, 2000)

However there were clearly two broad views of the CSF II documents among teachers in this study. One, the minority view, saw the frameworks as a springboard for designing the curriculum, while the other saw them as a constraint imposed on teachers from above. The first was more common among the primary teachers and is more likely to support knowledge building, because it allows for more open-ended content. In several schools teachers had a positive view of the curriculum frameworks (CSF II) and used them as a basis for designing learning, as these two teachers discussed:

> *Male teacher: They guide our checklists…*
>
> *Female teacher: …and our reports and our planning too.* [018]
>
> *Male teacher: So that's what our checklists are. Students make up certain points to complete certain outcomes. To show the understanding that they're gaining.* [019]

In another primary school, a teacher described how the team of teachers based their planning on the documents, without feeling constrained:

> *One of our former teachers here at the school was heavily involved in the CSF II when it was developed and we think it's a magnificent piece of work because it gives the teachers a wonderful starting base. So we have it open on three or four machines gathering ideas and using it as a starting board or a springboard for our learning. We also have a matrix of technology use in the school (male, primary teacher).* [004]

Just as Ball and Cohen (1999) believe teachers know little about how the curriculum is constructed, there are differing definitions of the term itself. The last teacher quoted, who commenced teaching in the early 1990s (before CSF II) indicated in conversation that he and his colleagues saw the curriculum solely as the content of the system-driven CSF documents, rather than as all experiences in the school. For some teachers, this can have the effect of reducing a sense of ownership of the curriculum. Other teachers in the study showed varying levels of familiarity with the curriculum frameworks, particularly with regard to technology, and many did not link the suggested technology uses in Table 4.1 with topic guides for teachers and students, or reports to parents. One secondary teacher made this typical comment:

> *In terms of assessing learning outcomes, I am aware of those CSF II documents and where learning technologies are suggested to be used, but I haven't really got into that in a big way yet (female, secondary teacher).* [007]

Generally, individual secondary teachers appeared to adapt the CSF II documents to their previous practices or to student interests rather than using them as a basis for discussions about curriculum. Some teachers were not very familiar with the documents and their potential. One described his attempts to maintain interest, presumably for the students, although possibly for himself as well:

> *The hardest part is finding something interesting in the CSF or the syllabus— whatever you're governed by — finding something interesting in it, and finding a way to make it interesting. Then you have the resources to make it interesting, and then get the lesson plan and chop it up a bit so there's a bit of variety (male, secondary teacher).* [015]

In the following comment from another secondary teacher, CSF 1 refers to an earlier version of the framework. There is clearly a feeling of constraint, and a suggestion that resources limit teachers' choices:

> *In some regards I'm disappointed with the CSF II, Middle Ages reappearing again. Year 7s get into it, but I think CSF 1 had a lot more flexibility. But now they're giving you a lot more of "You'll teach Middle Ages in Year 7 and 8". Sometimes I wonder if it's the publishers driving it. You know what I mean? I went to a History conference the other day and all the new books are coming out for SOSE, and she said "You do Middle Ages in Year 8", and I thought, "No we don't do it at our school, we do it in Year 7". Some aspects we do, some aspects we don't (male, secondary teacher).* [016]

Lack of familiarity can also lead to misconceptions. In spite of the fact that data logging is only one of the many uses of technology suggested for Science classrooms as shown in Table 4.2, one Science teacher perceived that the Department's documents promoted this exclusively:

> *Data loggers are very expensive and they're not always easy to use and you can't use them every day. It's one particular thing, but that's what our Education Department is telling you, "You have to have it". If you look through the Science CSF from go to*

> *whoa, their answer to technology is data logging (female, secondary teacher).* [011]

4.3 Teachers share a common discourse of planning

In recent years various design aids have been used in Victorian schools, including the linked design elements for the early years (Hill & Crévola, 1997) and matrices based on Bloom's Taxonomy (Bloom, 1956) and multiple intelligences (Gardner, 1999). Both primary and secondary teachers used the language of these aids, indicating a shared discourse has developed to some extent. In some schools these were part of the planning culture, while in others they were referred to as ideas used by individual teachers. Teachers in two former Navigator Schools had developed and documented particular models and discourses of planning, and made these available to other schools as part of their role in developing other teachers. They also used matrices to evaluate the design of the curriculum, as this teacher described:

> *In my opinion, Bloom and Gardner and methods of learning and understanding are tools that you can lay on top of the unit of work. They are not something that determines the unit of work. We ensure that we have covered a wide range of theory by the time that we develop a unit. On reflection we can say, "Yes, we achieved that by doing that". But we don't sit down any longer and say, "We must do it this way". We found that to be very constricting. We have it very much in the forefront of our mind, but we don't say, "We must get something in the verbal-linguistic section". It just doesn't work like that (male, primary teacher).* [004]

However documentation can still be irregular. When asked if the whole-school approach to teaching and learning could be found in one document, the Principal of one of these schools said this was not the case. At the classroom level Year 5/6 teachers in another school prepared a sheet of 42 student activities on the SOSE topic of government using a matrix informed by Bloom and Gardner, excerpts of which are shown in Table 4.2.

Table 4.2 Sample SOSE student activities (Integrated Curriculum, school H, 2001)

Knowledge/Word:	List all Australian Prime Ministers and their parties
Comprehension/Music	Drum/tap the Australian National Anthem
Application/Word	Write a letter of concern to your local member
Analysis/people	Research a biography of a past Prime Minister
Knowledge/self	List the things you would do if you were a Prime Minister
Synthesis/Body	Make up and perform a play about an aspect of the unit
Evaluation/Music	Write a third verse to Advance Australia Fair

Teachers using the activities of Table 4.2 in this school commented:

> *Male teacher: That's what they like about it, because they're all doing different things.* [019]
>
> *Female teacher: And they all choose things that they find easy to start off with, and it gets harder (primary school).* [018]

While the discourse exists and the terms are documented, using the tools in this way does not imply that knowledge building is either the purpose or the result. In the secondary schools there was little evidence of shared discourse, and most teachers referring to the same tools spoke as individuals, as did these three:

> *I try to look at multiple intelligences or de Bono's[2] learning styles. I try to think of a number of different activities which rely on different learning styles: learning through language, or they can learn through being involved in models or doing activities, so I mightn't do that all in one year, but at least over the course of the unit, I try to present them with those sort of options (female, secondary teacher).* [007]
>
> *With Middle Years, I run with Bloom's Taxonomy. That's probably about it. That always works well. The problem with that is that sort of assignment can end up being six weeks, in terms of the creative things that go on, but that goes down quite well with the kids (male, secondary teacher).* [016]
>
> *I tend to use Bloom's a little bit, start off with factual stuff and the grounding, and then try to have a few open-ended things in there (male, secondary teacher).* [015]

Only one teacher referred to a Victorian-based initiative known as PEEL (Project to Enhance Effective Learning), which is a process of sharing practice with other teachers (Baird & Northfield, 1992), as an influence on his curriculum design:

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[2] This teacher is confusing Edward de Bono with Howard Gardner (1984)

> *I feel that using PEEL, those sorts of things — where you are actually looking more at what you intend, what you want to achieve from it and then try and design activities that are going to fulfil that outcome— a little bit more useful (male, secondary teacher).* [001]

Across all schools, the discourse of teachers was found to be more reflective of the system-wide language or specific external programs than of locally generated (school-based) terms.

4.4 Teachers have a clear purpose for technology use

The importance of purpose for learning and for using computers is often noted (Blyth, 2002), and women are said to look for purpose in their use of the computer even more than men (Delaney & Dyson, 1998). The ways in which teachers design with technology mirror the three ways in which students use technology outlined in Chapter 2: consumption, (re)production and creation. The potential for knowledge building in the designing role is enhanced by communication technologies, such as the Internet and email distribution lists (Hawkes, 2000).

Teachers in this study generally had their own laptop computer which the Department of Education and Training expected them to use for curriculum planning tasks such as accessing information on the Internet, communicating with other teachers or preparing resources for class use. While some appropriated their laptop to familiar tasks such as preparing worksheets, several explored the potential for communication. In terms of using technology to support rather than drive the work of the community of learners, teachers oriented towards knowledge building had a clear view of its purpose for both teachers and students:

> *What we're attempting to do is move the learner from being a reader of that community to becoming a full speaker within it, and how they speak and how they act is different for each person (male, primary teacher).* [004]

A teacher writing in her journal described her use of technology to communicate with (teacher) stakeholders in planning a unit to be shared between classes in two schools:

> *The task I had to complete firstly was the joint schools' group planner for the Space project. This was finished with consultation*

> *from some of my team members and emailed to the whole team. All seemed happy with it as no one replied with any changes and it was posted on the City to Surf web site (female, primary teacher).* [026]

There are of course several other interpretations of *all seemed happy with it*, especially given teachers' professed lack of time. On the other hand planning appears to be an activity in which teachers readily invest time and energy. One member of this team of teachers emphasised how technology can serve several purposes through one project, in an article he wrote for a broader audience:

> *This project, using and developing collaborative planning models, provides a real life, routine, engaging and challenging way to utilise the technology in an appropriate and integrated way. It is seen as a highly-powered method of delivering staff peer to peer and student peer-to-peer professional development by the means of online mentoring using video conferencing, email and collaboration between the staff and students at both schools (male, primary teacher). [027]*

Consuming resources

Teachers in this study had varying views about the usefulness of the Internet sites previously vetted and recommended by the Department of Education and Training. Like most others who used the portal SOFWeb, this teacher found it useful:

> *There's lots of information that comes through from SOFWeb and there's an education web site that a lot of teachers tap into and that's got some really good activities with technology, and sometimes you find things by complete accident (female, primary teacher).* [022]

However one very experienced teacher, while interested to see what other teachers produce or suggest, preferred the freedom to explore according to her own purpose. Her comment can be taken as an indication of a thoughtful approach to designing curriculum, based on choosing resources to meet particular needs:

> *Maybe I just enjoy going through it myself. Sometimes I go and see what people have done. It's never quite what I would do (female, primary teacher).* [019]

In addition to the Department's recommendations, many schools use filters, which provide barriers to access to sites with titles deemed unsuitable for their students. Those who were prepared to take a risk with open-ended searching were disappointed when a site including a word such as *breast* was blocked. Others, such as this secondary teacher, felt that such open-endedness was too unstructured for students:

> *What's worked well for us is actually go through and find some appropriate Internet sites for the kids to actually start from and then give them a base from there. If they want to go beyond that and surf that and find other sites from there, well that's fine, but you have really got to give your kids some sort of useful resources to start with rather than chuck them to the wolves (male, secondary teacher).* [002]

For other teachers, the resources provided by the Department have been appropriated to existing pedagogical assumptions as suggested by Eraut (1991) and have assisted them to do familiar consumption and reproduction tasks such as *cutting and pasting* with new tools, although perhaps more efficiently, as this principal described:

> *It is so much easier than before. When you were trying to look at various books out there, they would be photocopying and cutting and pasting and photocopying again. Now they just go straight from that curriculum@work disk the Department's provided (female, primary principal).* [024]

Similarly a teacher described his consumption activity:

> *I probably use the Internet more now for preparation of classes than I use textbooks, because you can go to Google [search engine] and type in "Middle Ages lesson plans", and there's just hundreds of lesson plans. But they're not like lesson plans, activities, and you can print them off and there's your lesson (male, secondary teacher).* [016]

While sharing of curriculum materials could assist knowledge building by allowing teachers to know more about what others do, one teacher could not see the point in using computers in the way her colleagues did:

> *Other science teachers have given me different things that have been on the computer, but they are only just things that can be just photocopied off and done on worksheets in front of the kids, instead of looking at a screen and filling out the questions (female, secondary teacher).* [009]

This teacher had not yet found a purpose for using technology and provided an important questioning voice.

4.5 Teachers involve students in curriculum planning

Diaz, Neal and Amaya-Williams (1990) suggest that verbalising plans, rationales and goals encourages student self-regulation and Bober, Sullivan, Lowther, and Harrison (1998) suggest that teachers need to be more explicit with students about the goals for learning. Knowledge-building teachers might be expected to go further and include students in the planning process (Hill & Russell, 1999; Petraglia, 1998a). Since the responsibility for planning is normally vested in the teacher, this is an area where teachers need to take the initiative. Sometimes referred to as *negotiating the curriculum* (Jones et al., 1995), this can take place in various ways, although real negotiation may not be very common (Cherednichenko et al., 2001). As noted in Chapter 2, Scardamalia and Bereiter (1999) involved students at an early stage in planning with the curriculum frameworks.

Setting goals

Teachers in this study commonly shared curriculum goals with students in a general sense, while one primary teacher, echoing (Honebein et al., 1992) described his need to justify the goals to students as a consequence of their sense of *ownership:*

> *Kids have a lot more ownership of what they are doing, which is also challenging for me as a teacher because they expect a lot more from me. So I couldn't just come in and say "We are going to do this" because they would quite easily come back and say "But why, what's this doing for us?" So I have to think about how am I challenging them and why (male, primary teacher).* [003]

In this school a matrix known as a Data Chart (Table 4.3) is used when teachers work with students in designing units. The headings of the chart, reproduced below, make extensive use of the pronoun *we*, indicating shared ownership, while one area explicitly mentions sharing new learning with others, a term assumed in this case to be synonymous with new knowledge.

Table 4.3 Primary school Data Chart (Year 3/4 team, school B – Term 2, 2000)

	By the end of the unit we aim to know…
Questions	What questions do we have about the topic?
Class activities	What activities have we been involved in?
Where can we find out?	Where can we find the answers to our questions?
What have we found out?	
Sorting out all the info…	How can we sort and organise the information to work out what is important?
Sharing new learning…	What aspects of my new learning would be important to share with others? How will we present the info?
So what	What can I invent because of this new learning? What new questions has this raised in my mind? Is it important to know this?

One teacher explained that she then offers the activities as contract tasks, which students can choose from, although some are compulsory or *must dos*:

> *When you run contracts for your classroom, you just give the kids a range of activities across the intelligences … and with "must dos". So whatever the target learning outcome is at that particular time, it's a must do. Whatever intelligence I am trying to strengthen, is at the level of the must dos. They have a time frame that they have to meet (female, primary teacher).* [013]

In one typical mid-year planning meeting, at another school, Year 5/6 teachers used a brainstormed list of topics suggested by students as a basis for a new integrated studies unit. In the examples described above, the teachers worked together and the school culture encouraged and supported collaboration, often through email or Intranets. In contrast, many teachers in other schools in this study were operating individually in their efforts to design aspects of curriculum with students in limited ways. For example a secondary teacher acknowledged her students' interest in a topic and was prepared to allow plenty of time:

> *Some things need to be long, such as Australia at War. The boys in Year 9 class, are all hanging out for this. "When are we going to do it? How are we going to do it? So we'll run that for a whole term, a ten-week term (female, secondary teacher).* [008]

Planning assessment

Another means of involving students is in the development of assessment criteria or rubrics, which use a matrix where areas of the task are rated against three or four levels.

Students in primary schools were more often involved in determining rubrics for tasks than secondary students in this study. Students can make an important contribution to the language of the rubrics, as this teacher described:

> *One of the things we wanted to do right at the outset was to create a student multimedia rubric and project evaluation rubric. So what we've kept putting information out to the kids. "Does this make sense, is this what you mean?" Rephrasing the questions. The children have been very active participants. We'll put something to them and they'll say "that doesn't work, but this does." So they've been very proactive, but they always are (male, primary teacher).* [004]

In this case Year 5 and 6 students modified and simplified many items in the original draft assessment rubrics for a multimedia project, developed by the teacher. An area entitled *Project Flow* was added, and the draft descriptor *users can progress intuitively through screens in a logical path to find information* was changed to *the project flows well* (Student Multimedia Project Evaluation, school C, 2002).

Individual assessment criteria to be published at the commencement of a unit of work were sometimes devised with students on a class-by-class basis, as this teacher described:

> *Presuming that we had areas of negotiated curriculum to start with, the kids would work upon things that they had developed themselves. They'd developed their own assessment criteria. They might be working on a digital portfolio, for example (female, secondary teacher).* [025]

In most of the examples collected for this study, assessment criteria related to individual, rather than group, tasks, and did not include a requirement to share knowledge. One such set of criteria, published on a poster in the classroom, focused on the topics, heading, layout and presentation methods for grade 5/6 projects but did not mention process. An alternative and open-ended way of designing and building knowledge together, taking the focus off the containers of knowledge (Scardamalia & Bereiter, 1996a), was used by this secondary teacher:

> *Sometimes we [teacher and students] just plan something and then we might use all different ideas from different plans to come up with the class discussion. So when the class discussion is*

finished, that's it. I don't then expect them to go away and write it up themselves (female, secondary teacher). [007]

Role changes

Experienced teachers described how they were more involved in the design of the curriculum than they had been in their early days of teaching:

> *My role has changed. When I first got into teaching it was pretty much you just go in, stand in front of the class and teach, and this is what you teach. You were given a particular pro-forma to follow, which was probably done by the Principal and some teachers together (female, primary teacher).* [022]

In designing the curriculum in both primary and secondary classrooms, many teachers in this study maintained control over the content and the learning activities, while allowing varying degrees of student choice. Several teachers who attempted to involve the students in negotiating their own learning felt that the students took some time to adapt to this change:

> *It's a hard one because for years we've been telling them "This is what you do" and all of a sudden you say, "Well, what areas would you like to…" Some of them do but it takes them a while to get into it (male, primary teacher).* [005]

This is likely to be even more difficult in secondary classrooms if the school culture does not support it and the teacher sees the students infrequently, like this teacher who appeared to be resigned to the status quo:

> *I have tried to run classrooms where the kids have selected the types of topics that they do, from a list, and the types of work that they even create, but in the long term you tend to make the decisions about what they learn and how they do it (male, secondary teacher).* [001]

4.6 Teachers design in professional collaboration

Where teachers and administrators work together, sharing their knowledge, contributing ideas and developing plans for the purpose of achieving educational and organisational goals, they are engaged in professional collaboration (Leonard, 2002) and they contribute to the development of collective competencies (Cornu, 2001).

Formal teams

In schools where knowledge building was a focus, teachers met together to plan more frequently than the general allocation of half a day or one day during the term, and saw planning as an ongoing, recursive activity. Teams in these schools included a wider range of grade teachers and support staff than in other schools. A primary teacher described the move from planning across two year levels (Years 3 and 4 or Years 5 and 6) to planning for the complete cohort of Years 3-6:

> *In the past it's been the senior team 3-6 would plan, and the 3/4s would plan and the 5/6s would plan and at the end of every term we would reflect on the success of that current term and where we were going to move to in the next term. We'd spend a whole day where the staff from that area were released to plan. So we've gone from planning in teams, and having a planner with all sorts of activities and you as the one classroom teacher facilitating your maths, your language, your art and all those other things, to facilitating the learning for all children across that area (female, primary teacher).* [021]

The time committed to planning and reflecting was substantial in knowledge-building schools:

> *It's about being flexible and it's about the teams meeting regularly to reflect on how they're going and where they're going and what it is they actually need. That can be incidental, but it also is formal where they have an hour a week where they actually meet after school (female, primary teacher).* [021]

Knowledge-building teachers also used electronic communication to support their planning. Years 3-6 teachers in two primary schools in this study established a collaborative project during which they communicated by telephone, email (including a distribution list) and video conference to develop a unit of work. They were supported by the school leaders who also communicated in these ways. For example, teacher input to a set of assessment rubrics was collected through email:

> *The staff at [the other school] dissected it, and sent back their feedback to me, and that came via an email (male, primary teacher).* [004]

This team also held a joint face-to-face planning day, which was documented in this coordinating teacher's journal:

> *Small groups began to form and some of [my school] teachers began working together rather than with their partners from [the other school] which I had not articulated earlier to the staff but certainly was on my mind. In future I will ensure that teachers from [my school] are well aware that they are to begin collaborating from the very first meeting. I asked a number of teachers to switch seats in order that collaboration would be fostered…After trying to work in groups we began working as one team (this occurred by request of teachers in the group). Instead of trying to put the information straight into the unit planner which is something that teachers at [my school] do as a matter of course (due to the familiarisation with the subject matter) we began brainstorming ideas onto the whiteboard. Great ideas began to flow and each idea built on the previous ones. As we progressed teachers began perusing electronic resources and books for ideas and plans to add to the unit planner and the flow of the unit grew quickly…I look forward to watching this teaching partnership unfold over the coming months (male, primary teacher).* [004]

Loose groupings

Primary teachers reported planning together more often than secondary teachers, perhaps due in part to the medium size of their schools (Leonard, 2002). Secondary teachers reported that planning was more likely to take place within the Key Learning Area (KLA) or faculty group than across the curriculum areas, but in some schools, teachers did not often work together even within the KLA. Many secondary teachers used the singular when describing their planning method, and when asked how much planning went on with other teachers, one secondary teacher responded:

> *Not a lot. I work with [female teacher] and I pass on information to other people but we've got people that don't do any prep; they just take it (female, secondary teacher).* [008]

The dialectic between teaching as practice and as profession (Boyle & Skopp, 1998) was exemplified in several comments, and would appear to work against knowledge building. One KLA leader suggested that for the teachers in his team their classroom

practice is a higher priority than working with other teachers, but a consequence of the lack of collaboration is a heavy burden on the coordinators:

> *I guess I came in here two years ago with the attitude that the SOSE KLA is the most important thing and everybody should see it as that, but it just doesn't happen. It's their 4th or 5th priority after their own classroom, so… KLA leaders at this school end up putting our hands up for a lot of things. It would be good if there were more people prepared to have an interest in things, collaborate (male, secondary teacher).* [016]

Another articulated the impact of the school context and resource allocation on professional practice, suggesting that the effect of teacher differences (Rowe, 2002) is not only an individual, but also a contextual, issue. He explained:

> *We do plan together here, but how we actually achieve what we set out to do is very different. We make sure that all our assessments are common in SOSE, and we all do the same tasks, but how we might reach the endpoint in the presentation of that task may differ. But if you've got five Year 9 geography classes blocked on together, obviously not all of them are going to be able to use the technology. We plan the tasks thinking about equity but in reality there's not going to be, every teacher's going to teach the task differently (male, secondary teacher).* [001]

Culture of primary and secondary schools

It is notable that the comments above are from secondary teachers and are indicative of the views of others in secondary schools. The difference in culture and lack of connections between primary and secondary schools was strongly felt by most teachers in this study. Although a broad view of collaboration in education would include links between teachers in primary and secondary schools, there were few instances of this. One teacher described an exception:

> *Here we have students working with one of our local primary schools. They are working here all year in science and technology because they don't have access to facilities of their own. I reckon that's the way to go, partnerships between primary and secondary schools. That's where MYRAD [Middle Years Research and Development] has helped enormously; it's been*

fantastic because it's created links between primary and secondary schools (female, secondary teacher). [025]

4.7 Teachers plan purposeful tasks which require collaboration between students

While a sense of purpose is important for meaningful learning (Pachler, 2001), this is not easily defined. Some constructivists suggest that the learning task must be authentic in that the student has ownership (Honebein et al., 1992), while others require authentic settings (Brown & Palincsar, 1989; Brown et al., 1989; Wilson, 1993). Scardamalia and Bereiter (1999) suggest that the purpose of an elementary school class that takes a knowledge-building approach is to construct an understanding of the world as they know it. They distinguish between the project-based approach where products — the containers of knowledge — are the focus, and a knowledge-building approach where knowledge itself is the focus. While many knowledge-building teachers design collaborative learning environments so that students can bring multiple perspectives to an issue and build knowledge together to make sense of their world, Rowe argues for more teacher-directed classroom activities rather than group work and for clear objectives, detailed, simple instructions and clear assessment criteria, particularly for boys (Rowe, 2002).

Design of tasks

Some teachers in this study were adventurous, while others remained tentative, in their design of purposeful collaborative tasks. An assignment sheet for a major collaborative project between two schools set out the purpose and gave general process guidelines for working together:

> *Our aim is to understand how much Australia changed during the period 1788-1918*
>
> *You will be working in online groups across the Internet during this project. Make sure you share all your new learning with your group. The project will use a range of computer technologies including Microworlds Pro, web pages, Internet web sites, Netmeeting and eyeball cameras, email, scanners, CD Rom products and of course the trusty library.*

> *Give your group a name and list all students in the team. Create a distribution list for email.*
>
> *Create a storyboard plan of your assignment eg Design what each page will look like when the assignment is complete.*
>
> *Design a front-page timeline dating from 1788-1918 using Microworlds Pro.*
>
> *A reference page that lists the title, author, date of publication and editor of all books, references, resources, web sites and on CD-ROMs. (Student assignment guidelines, schools B and L, 2001).*

An important way of encouraging collaboration is to value it through assessment, such as acknowledging how well the team worked together, which was more common among primary teachers than secondary teachers. One primary school assessment rubric allocated points to both individual performance and teamwork, including the cooperation of members and sharing of the workload.

Authenticity

Teachers were clearly attempting to make tasks appear authentic, but in some cases their efforts were insubstantial, as in this *Country Study* assignment sheet where a secondary teacher attempted to engage students in the task by giving an apparent purpose, but with no encouragement to collaborate:

> *Through hard work in your after-school job, you have saved enough money to afford an around-the-world air ticket. You will be travelling with your best friend. From the five continents you are to visit one country from each continent.* [016]

After this introduction the task is rather mundane, including instructions such as:

> *Select the FIVE countries you are to visit. For each of the countries find out*
>
> *The total population*
>
> *The native language*
>
> *The capital city*

and so on. Another instruction stated:

> *Your friend wants some information and preferably some pictures about ONE tourist attraction in each country. (Student assignment guidelines, school G, 2001).*

Finally, after other similar tasks, the individual students were given the option to present their responses in various ways, including PowerPoint, but the only indication of intended audience given was the friend. The potential for knowledge building in this case was limited as an opportunity for group activity with a social purpose was missed (Resnick, 1991).

4.8 Teachers cross the boundaries between key learning areas

Curriculum frameworks documents, the jargon of various domains of knowledge, and the language of computing are all *boundary objects* around which the various communities of practice in a school organise their work (Wenger, 1998). However some teachers take on the role of broker, introducing elements of one practice into another. If knowledge building occurs when learners make links between existing and new knowledge (Fosnot, 1996; Jones et al., 1995; Selinger, 2001) it follows that a holistic approach to curriculum design allowing for links across knowledge domains will be useful. While the Key Learning Areas of the CSF II (Board of Studies, 2000) are separate entities, any links made between them would increase authentic learning and enhance knowledge building in the classroom. In several schools this was done through a time set aside for Integrated Curriculum, which was described in one school's curriculum document as follows:

> *Integrated Curriculum involves the integration of content key learning areas and process key learning areas. The content is selected from the key learning areas of Studies of Society and Environment, Science, Technology and Health. The process subjects, English, Mathematics, the Arts and Technology are used to organise, sort, represent and present ideas about the world gained from the planned learning experiences (curriculum document, school H, 2000).*

For one teacher in another school, this more holistic approach has had the benefit of developing thinking in the students:

> *I think that the integrated model has got us back to developing thinking skills, not being content driven (male, primary teacher).* [005]

In yet another school a teacher wrote in his journal:

> *Next Monday we will be planning the term's work and I look forward to this opportunity to integrate maths and English activities into our unit of work (male, primary teacher).* [004]

However in the secondary schools studied there were no links made between Science or SOSE and other Key Learning Areas (KLAs). All secondary schools offered separate subjects, but a team approach is not unknown, as one teacher commented:

> *The use of technology is blurring the lines between KLAs. At my last school we did teams so we did away with the junior KLAs and we had team leaders (female, secondary teacher).* [025]

One of the design features which makes it difficult to link Key Learning Areas and to share knowledge of teaching practice is the individual classroom intended for one class and one teacher, which was the case in every school. Even in a new secondary school building there were few internal windows and in some rooms, the glass panes of the doors were covered with paper. When this was raised as a concern in conversation with a teacher he replied:

> *You know I've had six weeks of student teachers, following me around and looking at what I'm doing, and it's just really taxing, because I'm not used to it (male, secondary teacher). [016]*

This reflects a common culture of isolation or privatisation in secondary schools, so that teachers who are *not used to it* find that opening up their classroom to others is stressful.

4.9 Teachers design for open-ended learning

While this proposition might appear contradictory to the previous one, together they highlight a paradox, or at least a balance to be struck in designing the learning environment. Purpose is important, but planning for openness rather than specifying all content in advance is essential for the constructivist classroom (Bednar et al., 1992). Attributes of a constructivist classroom include the use of raw data, primary sources and interactive materials to encourage multiple perspectives on an issue (Brooks & Brooks, 1993) and teachers need to be aware of the range of resources and ways of working with technology to support the curriculum at the planning stage (Loveless et al., 2001). Teachers can also be creative and make teaching resources themselves (Reid, 2002).

Creating space

Since the study was based in classrooms using computers, many teachers referred to digital resources and some to the creation of a virtual learning space (Burbules & Callister, 2000). Two schools became involved in projects designed to link them with external experts through video conferencing in an apprenticeship-learning model (Brown & Campione, 1994; Haslam, 2002; Mercer & Fisher, 1998). None of the teachers had done this previously, but they were prepared to take the risk to learn something new that they believed would benefit their students. While the outcomes were positive in their view, managing the technology to link with experts in other organisations proved to be a risky experience, as this teacher explained:

> *We had the whole procedure right. We thought it was right, we could communicate with ourselves, we could communicate with other schools, but we couldn't communicate with people in industry and we didn't know why. Now it took weeks, because of the security and the size of the bandwidth. I don't understand what it was…*
>
> *The people we had teed up, they were really keen. They hadn't used web cams before, the people who were doing it, and they committed a huge amount of time to trying to do it too… I think with all technology, there's always going to be things you come up against, but you don't think about first, and that's probably one of the difficulties, You're looking into the future, you're not sure of the specifications of it, how it runs, and even the technicians here hadn't used them before (male, secondary teacher).* 001]

In a similar project, a primary school built on its local resources by inviting experts from among parents and the local community and through the connections of a staff member:

> *He had connections because he was the computer business manager. So he had lots of contacts with various members of the community that had businesses. So we were able to tap into that. He was more than willing to give names and they were more than willing to help so we took that opportunity (female, primary teacher).* [022]

Choice of software

Teachers who used a constructivist approach had implicit guidelines for choosing appropriate software for building knowledge. A primary teacher articulated the argument of Leask and Pachler (2001) regarding the constructivist possibilities of generic software:

> *In my mind Years 5 to 8 — the middle years—are begging for four basic programs. If our educators across Victoria could become expert with these four pieces of software I think we could move mountains…They are: Excel, because Excel is used in Access, it's used all over the place not only as a database but a whole range of Maths and English activities. Microworlds, or Microworlds Pro, it's just more fun. It's the program that students can use to really express who they are and it allows them to be verbal, to use a linguistic approach, to be spatial, to use interpersonal skills, it gives them all of that. HTML web page design runs right across the curriculum … a program like Front Page Editor allows the kids to quickly slip between HTML, web page design and what they see on the net so they can get the feeling for it. The other one is Legodacta. So by the time that they leave the middle years they'll have this armoury of technology at their fingertips. If they do move into that field in the future, they're armed with the tools they need to go places (male, primary teacher).* [004]

Excel is a generic spreadsheet program, Microworlds Pro is a programming and simulation software, Front Page is for web authoring and Legodacta allows for programming and robotics. All four are *empty* (Zucchermaglio, 1992) until manipulated by users. Microworlds was commonly observed in the primary schools and known for its open-endedness and its capacity to simulate real-world systems. One teacher new to this software reflected:

> *The strength of Microworlds is that it allows for the multi-intelligences to be fully employed. Your musically talented being able to express themselves, the artistically talented, the verbally, all those sort of things (female, primary teacher).* [028]

Although there was little evidence of teachers in this study creating resources themselves, when coupled with students' ability to create high-quality products, this is a

likely area of growth in future. This teacher envisaged using technology for (re)production and creation of learning materials:

> *I just see it as an opportunity for teachers, or myself, in how I deliver the material, so instead of a hundred years of chalk and talk, we've got more breadth of opportunity in how I can get my material across. The way technology has developed in the last ten years, I think that in another ten years it will be so digital that we'll be able to make our own videos and our own bits of information (male, secondary teacher).* [016]

Discussion

As noted in Chapter 3, this study aims to provide direction for the future of teachers' learning based on emerging roles of teachers, as indicated, at the very least, by singularities in the data (Bassey, 2001) supported by literature. Within these guidelines, of the findings of this chapter indicate that it is likely among knowledge-building teachers that:

- teachers' understandings about student learning inform design
- teachers incorporate, but are not bound by, curriculum frameworks documents
- teachers share a common discourse of planning
- teachers have a clear purpose for technology use
- teachers involve students in curriculum planning
- teachers design in professional collaboration within and across schools
- teachers plan purposeful tasks which require collaboration between students
- teachers cross the boundaries between key learning areas
- teachers design for open-ended learning.

It is clear that teachers have built up a substantial knowledge base in relation to designing the learning environment, although their emphasis is more on the curriculum than on physical and virtual space. Although the notion of community implies place and space, teachers in this study rarely saw themselves as able to act on this environment at anything other than the small scale of the classroom, and even this occurred less in secondary than in primary schools. While teachers saw themselves as being responsible for facilitating the learning of students in the classroom, they did not engage as deeply in identifying systemic design constraints and problem solving around the design of space. Nor did they encourage students to contribute to the design of their physical learning environment. Within the classroom space, not one teacher mentioned ergonomics as a

consideration in designing the learning environment. They did not speak of designing software, although several described the construction of virtual spaces for learning based on Intranets and commercially available software.

The findings (especially 4.1, 4.2, and 4.3) indicate the potential of shared discourse to link Victorian teachers in a professional community, as well as in their school-based communities of practice. Although teachers rarely spoke of a holistic theory of teaching and learning or of a social theory of schooling, their understandings about learning tended to be articulated using the terms promoted by the Department of Education and Training through its Navigator Schools, and through other widely-available professional development sources. These included reference to the teacher as a learner, student inquiry, thinking skills and autonomy. The Department's curriculum frameworks (CSF II) provide a language for speaking about content and processes of learning, which is widely available if not always used. The discourse of planning processes and associated tools is common to many teachers and has been disseminated through popular professional development activities. While the teachers use familiar names (for example, Bloom, de Bono) their understanding of the tools was in some cases superficial, which might account for the confusion some expressed. De Bono's Six Thinking Hats (2000) provides a strategy for parallel thinking, while Gardner's (1984) multiple intelligences allow for self-understanding and Bloom (1956) provides a taxonomy useful for designing tasks. They can all assist in designing for knowledge building in different ways.

Teachers' shared discourse is likely to be important in supporting knowledge building on a broad scale. However teachers' attitudes to the curriculum frameworks documents could work against this. Many teachers found the documents a constraint, based on their origin (mandated from the Department), their structure (scope and sequence charts) or their content (suggestions for topic areas). Perhaps this is not surprising as many teachers in this study commenced their careers in an era when Victorian schools had no mandated curriculum and teacher freedom was at its peak. These experienced teachers often have a strong sense of professional efficacy. Increasing Department involvement in mandating changes in schools over the past ten years appears to have resulted in some

teachers, particularly in secondary schools, feeling that they lack control over curriculum decisions. For others, particularly where the school culture encourages teachers working together, teachers are able to use the frameworks as they are intended: as empty structures to be filled with exciting and relevant activities. This stance is more likely to result in knowledge building. There is some tension between tools based on a network model supporting knowledge building, and others that are hierarchical, encouraging lock-step progression through bodies of content.

In terms of decision-making regarding design of the learning environment, the data show differential input from the main stakeholders, students and teachers. Within the classroom community many teachers in this study displayed specific design behaviours that were likely to encourage knowledge building. In some classroom cases, and to varying extents, teachers involved students in designing their curriculum, including topics, tasks and assessment. Most teachers attempted to take into account students' prior experience, although this was better developed in primary schools, where a greater sense of continuity of relationships was evident. Email was used as a resource to support student and teacher collaboration in design, particularly in primary schools, and even by teachers with relatively little familiarity with the medium. It appeared that where teachers wanted to negotiate aspects of the curriculum they had a purpose for the use of technology. However all teachers in this study found face-to-face communication an important aspect of working with students and other teachers.

The findings regarding teacher collaboration differed markedly, such that primary and secondary schools seemed to have quite different cultures. Several of the primary schools were structured to encourage teachers planning, working and reflecting together through team arrangements and time allocation, supported by electronic communication. It appeared that teachers in these schools had a clear purpose for, and confidence in, working together. On the other hand, teachers in the secondary schools in this study were often acting alone, or sometimes in a learning area team, but rarely expressed a whole-school approach to designing the learning environment. Collaboration across schools tended to reflect this demarcation as only primary teachers (in three schools) mentioned it. Although the potential exists for Science or SOSE teachers in different

secondary schools to plan together, this was never mentioned. Similarly little contact occurred between primary and secondary teachers, although all participants in this study covered the middle years around the transition between the two.

The findings relating to the design of tasks (4.7, 4.8 and 4.9) highlight the importance of both purpose and openness. In most of the classrooms, teachers planned for long-term inquiry and the production of major projects rather than short-term and fragmented activities, although in one school committed to knowledge building, teachers justified planning for quick rotation through activities as reflecting the pace of the real world. In terms of the three aspects of technology use outlined in Chapter 2, teachers tended to design tasks emphasising consumption and (re)production rather than creation. Teachers attempted various degrees of *situated learning* in designing tasks, but in many instances this would scarcely satisfy its proponents. Where the curriculum frameworks were seen as a constraint, teachers appeared unlikely to design *authentic* activities. Teachers designed for informal collaboration between students in many cases, both in the physical environment, the choice of tasks and in some cases, the software chosen, but rarely in designing assessment. Even where teachers designed tasks to be completed by a group of students, the assessment was individualised to suit the reporting processes suggested by the CSF II documents. As noted above, teachers rarely displayed ownership of the statewide curriculum. Some teachers crossed boundaries and made connections between disciplines, classrooms and school types in designing the learning environment, and pushed for ongoing contact. However the structure imposed by physical layout, timetabling and telecommunications capacity was often a challenge, and where it was overcome, it was usually as a result of support from school leaders, other teachers or external sources. Some teams of teachers were able to achieve a dynamic balance between purpose and open-endedness. Teachers who designed for open-ended learning displayed flexibility rather than control of content and process in designing tasks, and used technology to support exploration, both through the actual design process and in planning student tasks.

The findings of this chapter are presented in the language of social constructivism, both in terms of the teacher-student relationship and the professional relationship between teachers. Together they represent current behaviours, which are likely to support

knowledge building in classrooms and across schools. Knowing what teachers know and do in this regard is important in terms of Hargreaves's (1999)call for audits of teacher knowledge. However while curriculum structures and outcomes were documented to varying degrees, few of the design processes were documented within schools, and there were only two examples of schools sharing their processes widely. Knowledge-building teachers wishing to make links with other teachers have to change established practices for themselves and with others. The findings indicate that in some cases this would require substantial structural and behavioural change, and Chapter 8 takes up this discussion.

The role of teachers in designing the learning environment sets the context for both student and teacher learning and is therefore a crucial and fundamental role, affecting all others. In the following chapter the role of managing people and resources will be examined in terms of its potential for knowledge building.

Chapter 5 : Managing people and resources

In the previous chapter, the role of teachers in designing the learning environment was depicted as being concerned with relatively long-term concerns of curriculum design and configurations of learning space. The management role takes place within this context, operationalising the goals of the designer on a daily basis, and research indicates that the management of people and resources is an important factor in student learning (Wang et al., 1993). In light of research that indicates new organisations are networked and organic in structure (Morgan, 1986) and are characterised by collaboration (DETYA, 1999) Figure 5.1 shows the focus of this chapter, which examines the aspects of management which support knowledge-building in relation to classrooms using technology.

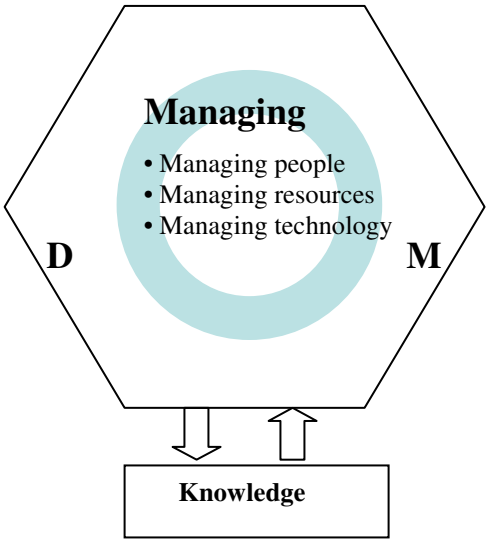


Figure 5.1 Managing people and resources

As the literature reviewed in Chapter 2 noted, teachers manage relationships with students, staff, parents, experts in the community and other contributors to the learning process, expanding the notion of the school as a learning organisation. They want people to feel a connection to the school community which, as Falk and Kilpatrick (2000) argue, builds a sense of belonging as well as providing the framework for people to re-orient their views of self and others in order to be willing to act in new ways: in other

words, to learn. Teachers are said to be flexible and opportunistic (Jackson, 1990) and they have initiated or responded to the introduction of computers in various ways. In coping with a high degree of uncertainty and ambiguity, they create varying degrees of structure, including the arrangements for students to learn individually and in groups, expectations of the level of freedom allowed, and controls over resource use.

Introducing computers into schools has required many high-stakes decisions to be made about management structures such as timetables, allocation of teachers to classes and location of computers in labs, pods or classrooms — due in part to the major investment made in the technology — while also offering opportunities for new types of learning. Research in the middle years of schooling in Victoria has suggested that the rigidity of school organisation practices which allow students only short periods of time on particular activities is not conducive to optimum learning (Hill & Russell, 1999). On the other hand, Elmore, Peterson and McCarthey (1996) were unable to find evidence that changes in organisation lead directly to changes in teaching and to improvements in student learning. The explanation for this paradox could lie in Rowe's findings that the teacher in the classroom makes the difference (Rowe, 2002).

Social interaction in a community of practice is seen to be an essential pre-requisite for knowledge-building, whether in face-to-face or open-plan environments or supported by high bandwidth (Heppell, 1993; Salisbury, 1996), and managing this is important. However the design of the school as a workplace influences, and often impedes, both teacher-teacher interaction (Nias, 1987) and teacher-student interaction, as noted in Chapter 4. Managing scarce resources, such as wherever there are fewer computers than students, can range from highly controlled to laissez-faire. Where equitable access is a consideration, the teacher must play a role in managing and monitoring resource use, as research shows inequities can arise in laissez-faire environments.

The analysis of the data led to six propositions in relation to the role of the teacher as a manager of people and resources for knowledge building, which are supported by the literature. In every case there was a range of commitment to the proposition: some teachers strongly displayed the behaviour, while others were less likely to do so. As in

the previous chapter, the propositions are presented as numbered headings, while teachers are identified by gender, school type and identification number.

5.1 Teachers involve students in management

In the constructivist classroom students are autonomous, or self-directed, learners, free to take risks in learning, assess their own progress and develop the insight necessary to improve their own learning (Brown & Palincsar, 1989; Freire, 1993; Goodman & Goodman, 1990), and technology is expected to support this. Through self-management, students are expected to learn how to learn in order to be lifelong learners. Managing to this end demands a dynamic equilibrium balancing structure and openness, depending in part on the management skills of the students and the willingness of the teacher to relinquish control (Nias, 1987).

Student self-management

Teachers in this study generally encouraged students to manage their own learning both individually and in groups, as this teacher described.

> *Kids are self directed, self-motivated, self regulating, so… trying to get them to focus on themselves as a learner, develop metacognitive skills, to recognise strengths, weaknesses in learning to know. Building in that responsibility for self, time management and the contracts, that's what I am about with the kids here (female, primary teacher).* [013]

One primary student, writing in her school newsletter, reflected on the freedom she enjoyed:

> *Your computer can help you with anything you need. You can type up all your stories without them getting messy. You can load on games if you have enough memory. But the thing I like the most is that you can do anything you please (female student in newsletter, school J, 2002).*

In the primary schools groups of students were observed frequently, ranging from teams with formal, if short-term, membership, to fluid groupings of two or more students. Those teachers who encouraged self-management were prepared to step back and allow students time to organise themselves in groups, valuing the collateral benefits to students

of not interfering in their choice of group members. One teacher described how students organised themselves:

> *I've got kids that always choose friendship groups to work with and I try not to interfere with the way kids choose the way they work. I try to get them to talk to each other and find out who's got a common interest, to work with a like mind. They always make out that they think the same as their best friends anyway, but I have got kids at the top end, the real high achievers, down with the kids who are real strugglers. They seem to team together really well. What do you call them? The collateral learning outcomes, the spin-offs from using technology. Working cooperatively and peer tutoring and problem solving and troubleshooting: being more responsible (female, primary teacher).* [013]

Another described how the students handled the workload:

> *It was basically self-regulated learning, because… each group was telling each other what they wanted to do. That took a little while, in the timeline, who was going to do what: "So which part are you going to do first? Is it Ned Kelly? What history?". When they sorted out the six topics, then they collaboratively worked out who was going to take what. Therefore they did it fairly (female, primary teacher).* [026]

Teachers also took their duty of care seriously in managing Internet access, in at least one case involving students and parents in protocols for safe access and cautious publication of personal information. At the same time some saw freedom for students to explore as equally important. A secondary teacher felt that freedom of choice also gave students the opportunity to cross curriculum boundaries into areas of personal interest:

> *If they perceive that they've got a choice, the quality of their work will be better than it is if they feel they are being coerced or forced into it. So to be autonomous is desirable because it presumes that you are giving the chance for somebody to go outside some of the normal boundaries and continue in an area that they have some sort of interest (male, secondary teacher).* [001]

In spite of teachers' beliefs about self-management, they found at times that some students did not work well together when they chose their own groups or pairs. As a

result, they intervened to group students to encourage skill and knowledge transfer, such as one primary teacher who actively matched students with information-gathering skills with those with technical skills.

Managing with technology

Because students who have grown up with technology were often more skilled than their teachers, they were frequently allowed to take responsibility for learning tasks. Although this teacher was relatively tentative in his comment, he reflected the common view among teachers in this study, that they do not need to know everything:

> *The other thing I've found is that the kids are so much more confident now and therefore it's made me a little bit more confident. I can almost say to them "Maybe we can get something from the computer that will help us", and the kids can go off and do it, and I don't need to know it. One thing it does help them to do, in terms of work patterns, is to make them more independent learners (male, primary teacher).* [005]

In a collaborative project between two secondary schools a teacher reported setting a relatively open task that resulted in the students displaying initiative:

> *I said "This is what I want you to use. You go to somewhere, you get a clue, you go somewhere else and you do clues off those sites". Now about four of them very quickly set up a Hotmail account and used that to post their questions. They are going to do that every day so that the kids get their answers and have to go to sites. It's not something that I [required]… but I was just very excited about it (female, secondary teacher).* [008]

However some students require more encouragement and support from the teacher to use technology, as this teacher described:

> *You do have to challenge them, most definitely. I find the group I've got this year I have to suggest to them what to do, like with the multiple intelligence 42-matrix thing. "How do we do these?" We've got a C on all the ones they can do on the computer, but they don't naturally think of that themselves (female, primary teacher).* [018]

While many primary teachers spoke frequently of self-managing groups, secondary teachers tended to focus on the capacity of individual students to manage their own work. Several teachers, including this one, raised the issue of giving away some control:

> *But in terms of autonomy, you try and give the kids as much freedom to use their areas of expertise as possible. So you are giving them some control. I think the word control is pretty important, some control over what they actually do, instead of you being the big ogre standing over them (male secondary teacher).* [001]

Another secondary teacher described a self-managing student as one who is not thwarted by technical problems, is able to *change tack midstream* and change priorities regarding both information and its sources. But in yet another school one student who found the classroom computer cumbersome and asked her teacher if she could bring in her laptop was not allowed to be so flexible, as he said:

> *You get things done if you're patient. It teaches you to be patient (male, secondary teacher).* [015]

Although Boyle & Skopp (1998) suggest that teachers know how to manage students based on cultural norms and codes of conduct, teachers who wish to empower students and allow them to experiment with their learning are also faced with managing new forms of communication and expensive hardware. For experienced teachers particularly, the introduction of technology with its associated malfunction challenges their role in classroom management and calls for new problem-solving techniques, frequently involving students. One teacher reflected:

> *I think the aspect of control is interesting, because I find in a room with technology, if something goes wrong I am not in control (male, secondary teacher).* [001]

In this case the teacher was referring to students' ability to trouble shoot and assist in the smooth running of the equipment. This was observed in numerous classrooms. All teachers also experienced occasional management issues that they believed required discipline strategies, such as students mistreating equipment or affecting the learning of other students They had generally devised strategies to deal with these, either individually or within the school's code of conduct. Students did not appear to be

involved in these management decisions. In some schools where, it could be argued, technology is not yet integrated, those who experimented by interfering with computer settings were generally frowned upon, as this sign indicated:

> *Hacking the network or tampering with the set-up will result in the most unpleasant consequences for you (sign in classroom, school E, 2000).*

Student self-management, a long-term goal for many of the teachers in this study, was enhanced by whole-school strategies that allowed students to make decisions about how they worked and with whom, and the products they created, while providing flexible structure and support to students. It was impeded in some cases by students' and teachers' prior experience and levels of flexibility.

5.2 Teachers encourage student motivation through intrinsic means

A constructivist approach tends to value intrinsic rewards in contrast to the treats offered in some traditional classrooms (Jackson, 1990) or even grades and the promise of future benefit (Dexter et al., 1999). In the early days of computer use in classrooms, teachers sometimes used access to computers as a reward in the extrinsic sense, but the facilitator relies on students to be motivated by a desire to implement the purposes which have meaning for them (Rogers, 1969).

A purpose for learning

A recent Australian study found that successful engagement conferred social power on students (Cherednichenko et al., 2001), and this was echoed frequently by teachers in this study, as this teacher expressed:

> *The students become intrinsically motivated and they know how to learn. They know how to find out what they need for a specific purpose. I don't think it relates to teaching at school, it's just life, regardless of your age (male, primary teacher).* [016]

Many teachers in this study focused on purpose and incorporated recognition of achievement into the daily activities of the class, whether this was part of the whole school culture or not. One teacher underlined the importance of this:

> *A lot of students don't see school in the traditional sense as being relevant or they don't see any other rewards in the school context, which is very disappointing for them. But I think it's why, when they leave school, a lot of them actually achieve a lot more because they are in a situation where they are learning for some purpose (female, secondary teacher).* [007]

Other teachers in a specific project described how students were motivated to learn and achieve when working on a meaningful project that connected them with outside experts:

> *Once we started connecting with people the kids had a purpose. A task that they had to do, or they had something to work on and that kept them motivated. They were just so rapt that they had someone from outside the school that wasn't a teacher. It wasn't that they didn't know that they were still part of the community but they were sort of removed and it was exciting for them to have someone else to talk to. Someone that had a different angle or understanding of what they wanted to do and that was unbelievable for the kids. Those kids just walked out of here completely different (female primary teacher).* [022]

In spite of many students' intrinsic motivation to achieve, the teacher's role in encouraging and trusting students cannot be ignored, as this case shows:

> *I thought we needed to get [a particular student] in and we wanted to boost his confidence, because at that point we could have seen him become a behavioural problem or just melt away in a corner. So we pushed him into it and he was very hesitant at the start, didn't want to do it, wasn't sure, and then [other teacher] got talking to him. The guy from the Rotary club was emailing him telling him what he wanted to do. So it was those two connecting: not me, not [other teacher], so he had to do it and he thought "Well someone else is depending on me now" (female, primary teacher).* [022]

Showing that the output of student work is valued is also part of the teacher's role. Many teachers encouraged students to present completed projects to the class, while some also encouraged students to invite parents. While several of these sessions were observed, no other teachers were present. One teacher was observed discussing arrangements for morning tea to accompany the forthcoming oral and visual presentation of project

reports. Students volunteered to bring biscuits and cake and the teacher offered drinks. Later she reflected on the flow-on benefits of such an event:

> *We had a gig last year in Yr 9 for the Australia at War thing. We got 6 or 8 [parents] and it was fantastic, just wonderful. We videoed it, and put it up on the web. It's that publicity stuff with kids, and letting their parents know this is what they are doing (female, secondary teacher).* [008]

The effect of technology on motivation

While some teachers claim a positive effect of computers on student motivation, others like Papert (1991) see the task, not the technology, as enhancing motivation:

> *It's just like anything; you have to put the time and effort into it. You have to make sure that whatever you do challenges and motivates the kids, because you just can't give them anything if it's boring and doesn't excite them. It's the same with technology (male, secondary teacher).* [016]

An indication that students see their time on the computer as purposeful could be the excitement they display, as this teacher reflected:

> *There are certain days in my class, where they are on computers, they've got to organise. There are definitely children excited about "This is my turn on the computer, I am doing this today" and there's always a bit of an outrage if they miss their day for any particular reason. So they are definitely excited and engaged by it (female, primary teacher).* [012]

There were few indications that teachers (or students) considered engagement in relation to gender, although one primary school (C) had a list of *"eight tips for getting girls involved in technology"* on its web site. Some teachers established short-term learning centres within the classroom for student rotation, which according to Rowe (2002) should particularly suit boys. One teacher described them:

> *Quick learning centres, quick activities for them to go through. Grab a digital camera and take a picture of yourself, now do this, now do that. So it's constantly lots of activities including technology as well, computer, digicam, video and making things with their hands as well, so it includes everything really (female, primary teacher).* [022]

In contrast to some of the findings in the literature (eg. DETYA, 1999), several secondary teachers, like this one, found girls very active in using computers for collaboration and communication:

> *Learning technology is good for group learners and particularly the girls. My biggest problem with them is "No, you can't have five in the group" (female, secondary teacher).* [008]

On the other hand, two teachers in another school saw benefits for boys:

> *I've been teaching for ten years, and there's more flexibility. You're not just stuck to the room all the time, to pen and paper things. In particular boys get more out of it. They enjoy working with the computers more. They don't see it as work. That's something I've sort of tapped into (male, secondary teacher).* [016]

> *More girls find computers boring than do boys. Some girls see computers as being too technical and can use this as an excuse to avoid engaging in computer technology (male, secondary teacher).* [015]

The gender of the teachers in these situations could provide a clue to the differences in observations. However it was personality rather than gender that this teacher observed:

> *We do Web Quest so I've two or three around one computer. It's the same little turk who'll just move over and take over the mouse and it's the same quiet boys and girls that miss out on that stuff. So I want everybody to have a go (female, secondary teacher).* [008]

In contrast, in a primary school one teacher reflected on the change in social relations she had noticed in recent years:

> *I'm always amazed at how well our kids seem to get on with each other, you know boys and girls. I often think about this. Even just a few years ago boys didn't want to sit next to girls, and I think it's a whole social change that may be happening. I don't know if it happens at other schools (female, primary teacher).* [018]

Her final sentence is illuminating for another reason: this experienced teacher had little knowledge of the situation elsewhere, and in fact frequently asked questions about other schools.

Like their teachers, students appear motivated to use technology when they see a purpose, as these two teachers indicated:

> *They found that their project work is easier, more effective and they used the word 'classy'. They save so much time by using the tools. There will be some students who don't like using technology. Occasionally they will say, "Look, I really don't want to" and that's fine. If they can legitimise why they want to do that and why they don't need the technology for an activity, then that's not an issue (male, primary teacher).* [012]

> *Students are interested in new applications, but are not easily fooled by new applications that don't have intrinsic value (male, secondary teacher).* [004]

However in the Victorian context where research has found students' attitudes to school declined in the middle years (Hill & Russell, 1999), some secondary teachers, like these in two different schools, also found that some students appreciated the access to technology as an extrinsic motivator:

> *The reason I like using technology is kids, who have been turned off in the traditional classroom, all of a sudden open their eyes when they walk into an area outside their realm of experience, like kids in a lolly shop (male secondary teacher).* [001]

> *Just the fact that they will volunteer to it, whereas if you said to them "Write that down in your workbook" they would just sit there. They wouldn't be engaged in what you are asking them to do. So the fact that they will volunteer, they are prepared to get on the computer and do something (female, secondary teacher).* [007]

Although teachers in O'Rourke's (2002) study found that it was easy to engage students in using the technology, but more difficult to engage them in the social and intellectual purpose of the task, the teachers quoted here generally focused on a purpose for the task, and encouraged students to use the technology as a tool to achieve that purpose.

5.3 Teachers model collaborative knowledge-building and management practices

If self-management and student collaboration are important to in the classroom, teachers should show leadership and model these behaviours themselves (Renshaw, 2002) and leaders should ensure collaboration among staff (Hill & Russell, 1999), actively

engaging in and supporting collaboration by sharing their leadership authority (Hord, 1997). On the other hand, if teachers themselves are dependent on external authority they have difficulty in accommodating to new ways of thinking and behaving (Nias, 1987).

Structural change to support collaboration

Several schools in this study had taken some steps towards greater teacher collaboration. One school had changed its arrangements to allow for team responsibility, shared teaching and other forms of collaboration among staff suggested by Hill and Russell (1999), as described by these school leaders:

> *It's not about your grade of twenty-six or your grade of twenty-four. They're all our children and we all collectively, including the office staff, the grounds man, the Principal and myself, see they are all our children. It's about educating our collective group of children (female, primary assistant principal).* [021]

> *Everybody teams together and they work together as teams. We all have days when we just think we can't cope with one other thing, so the team comes into action and people support each other. I think that the collaboration and the working together, the teaming of kids, groups, nominally having home room groups but in fact the children are actually owned by the whole team…* [023]

> *Well now the teachers are coming back and saying, "Oh, I don't know why we haven't been working like that for years". It's a bit like the tribal mentality: everybody takes responsibility, extended family… and it's not so daunting for one person (female, primary principal).* [023]

On a smaller scale, two teachers in another school opened the folding door between their rooms and shared the teaching of their two classes, while the timetable was changed to allow a library specialist to team with a class teacher at certain times, as a teacher wrote in her journal:

> *This way the class has two teachers working with the grade doing the VC [video conferencing] and the expertise of staff when doing Microworlds, as these tasks can be heavy going (female primary teacher).* [026]

In yet another school where teachers did not team teach, but shared a *pod* of computers between two classrooms, one of them reflected on the benefits of the arrangement:

> *I like the way that he can just come in at any time and vice versa. Sometimes we have both doors open. I suppose we both work with the same amount of noise. It's just luck I suppose, that two people teach similarly (female, primary teacher).* [018]

However the arrangement constrained teacher-student interaction:

> *I certainly trust the kids. They've got jobs to do and they get along with them. But even for a simple little problem or mistake I would very easily go and help out if I could, whereas they hesitate to ask because they know I'm taking a group and they can't see me (female, primary teacher).* [018]

Using technology for building and managing knowledge

Knowledge-building teachers might also be expected to model technology use in their management, in contrast to the findings of Evans-Andris (1996), who found that teachers expected students to use technology but did not demonstrate its use themselves. Teachers also valued modelling by their school leaders, as in this case where a teacher reflected in her journal on two principals communicating in a project across schools:

> *It is good that the leadership team is now [video-conferencing] as the principals realise what frustrations and resources are needed to get things happening. The Principal and Assistant Principal were involved last year to a certain extent but did not see the real life problems faced by the class teacher when things went wrong. I felt like I had much more support this time, both from my Principal and [other school] Principal, which was good (female, primary teacher).* [026]

Where leaders modelled knowledge-sharing behaviours, teachers were encouraged to then model these behaviours to the students, as this teacher expressed:

> *We try not to allow them just to watch the other students. Instead we will challenge them: "Look if you know something you must share it". This is something that we try to model as classroom teachers (male, primary teacher).* [004]

Technology can provide a repository for information and new knowledge created within the community. Students in one school used a linked computer system to display the

work of all participants as they typed information in, displaying the *wisdom* of the whole group, as this teacher described:

> *We've used it for brainstorming, but we'd like to extend its application here because when the kids are all typing you put it on the screen, you end up with all the wisdom. The teachers are not turning their back to write up the brainstorm. The kids get to see their ideas as they're putting them up. We've used that for de Bono's thinking skills (female, primary teacher).* [010]

Intranets were the most common form of knowledge management, but in most cases the life of this storage was less than one year, as server space was continually required for new projects. As teachers and students in this study saw more possibilities for computer communication they were often met with problems of network overload or limitations to available bandwidth, resulting in timetabling solutions or new rules:

> *You are not to operate applications across our network as it can, and often does, result in the network falling over or the students losing work (curriculum document, school F, 2001).*

Email was a popular form of communication among some teachers, but, for various practical reasons, this practice was not universal. Teachers from two schools in a joint project were the most enthusiastic users:

> *Our email is up all the time and we use it regularly for passing the minutes, through to announcements and notes. We try and engender that culture into the project so the teachers are emailing four, five, six, eight times. If it's a case of myself and my protégé [teacher] we are on the machines every ten, fifteen minutes talking about everything from student issues, to teacher issues, to administrative issues (male primary teacher).* [004]

However as a reminder that these communication practices challenge but do not necessarily change existing hierarchies and cultures —and thus do not represent true collaboration (Ducheneaut, 2002) — messages on the distribution list (DL) in this case tended to work down to all and up to the sender rather than across the membership. One of the two project coordinators responded to a question about this feature:

> *Occasionally it is a communication thing as the sender wants information and the team here is not sure who will reply. So they usually leave it up to me as the co-ordinator. However, I know*

> *that DLing your replies would alleviate this whole problem because then everyone would know that I replied and they would be able to see what I wrote so all would be in the know, so to speak. I am chastising myself for not using this more often and will endeavour to do so more in the future. I spoke to my team this arvo and one member told me that communication between herself and her paired partner at [other school] she believes really isn't what everyone else in the whole team would want to see. I am talking about the general everyday project issues that arise between grades. So that is another reason why some don't use the DL. I think that this WILL [sic] change in the future as people become more open and comfortable in the group situation (female, primary teacher).* [026]

While Hawkes (2000) identified the benefits of reviewing and reflecting on list serve communications, this very process was seen as an obstacle to communication:

> *…because once you write on the distribution list they know that you have to revise, edit and make sure that what you've said is clear and accurate. So people avoid it if they can… I would equate it to the difference between an Intranet and an Internet in a school. The Internet is your public face. The Intranet is that warts and all discussion, because teachers operating within the field need to be careful about what they say. And they need to be professional about the language they speak (male, primary teacher).* [004]

Collaborative management practices were found more commonly in the primary schools, where teachers often used the pronoun *we,* while secondary teachers tended to use *I*. On a practical level, collaborative management was enhanced to some extent by the use of electronic communication and by sympathetic structural and timetable arrangements.

5.4 Teachers manage technology as a resource for students to build knowledge

Since communication technologies can provide opportunities for collaboration, which allow students to perform at a higher level than they would independently (Vygotsky, 1978) teachers who see the potential and manage access to technology accordingly, promote the construction of new knowledge through social interaction (Imison & Taylor, 2001; Leafe, 2001; Scardamalia & Bereiter, 1999; Sproull & Kiesler, 1991; Wiegand, 1998). However this was an issue which teachers in this study found very

concerning as they attempted to manage access to the scarce resources in an equitable way.

Allocating scarce resources

A fundamental belief articulated by most teachers in this study was that students should have maximum access to technology, and many of their management decisions were attempts to ensure that this occurred. For some schools the underlying principle for the use of computers was *routine and appropriate,* as one teacher expressed:

> *There are times when we don't use them because it's not appropriate but they're here when we need them. So the kids can go to the machines if they feel that's going to empower them (male, primary teacher).* [004]

A collaborative project between two primary schools provided rich data as teachers and students grappled with access to video-conferencing technology for online collaboration. This teacher wrote in his journal as he tried different ways of organising student groups across Years 5 and 6 in two schools:

> *It will either mean 2 grades working with 2 grades or 2 grades working with 3 grades or 2 grades working with 5 grades but not all students at [the other primary school] being involved in the online interaction. Tuesday 23rd April teachers and administrators from [the other school] will come to [this] school for a half-day meeting session. This will be the time that groupings will be decided upon. I am most anxious about the results of this meeting and I hope we can formulate a reasonable plan of attack to best suit the needs of participants (male primary teacher).* [004]

After the meeting, he wrote again that the fundamental principle for grouping was to be for maximum involvement:

> *The meeting…addressed many issues but the one dominating discussion point was that of grouping teachers and students from the two schools to allow for maximum involvement (male, primary teacher).* [004]

Other management strategies for access included rearranging the allocation of teachers to classes, resulting in smaller group size in one school:

> *Reducing class sizes and increasing the number of teachers involved at the Mentoring school has been a certain success although it has been a financial cost to [this school] employing a teacher to support the project one day per week. Teachers have reported that they can give more time to groups and students in the project as a result of this decision (male, primary teacher).* [004]

Once the project commenced he explained how he managed access and encouraged collaboration within the classroom, placing students in groups of three to complete the tasks:

> *So the students have hopefully got their information prepared, they're ready to get on line and they've revised their questions, they know what they want to talk about. So when they get close to base, one of the students is operating the mouse, one of the students is operating the keyboard, and the mouse driver will also have the headphones on and be doing the speaking. The third participant either observes or is involved where they need to, as an information gatherer, reflector, a number of different roles (male, primary teacher).* [004]

Figure 5.2 shows two students in the second collaborating school video conferencing, while others in the class work in table groups. One girl wears the headphones and microphone, and the camera is on top of the computer monitor. Some computers are not being used at present, but they are always available to the students as this is their class homeroom.

Figure 5.2 Students video conferencing (school L)

Students working together

As a response to scarce computer resources (with a computer-student ratio of about 1:6 in primary classrooms) many teachers allocated pairs of students to computers, or encouraged students to work together in informal pairs, with both practical and pedagogical benefits. Several teachers set up skilled students as *gurus, wizards* or *mentors.* One very experienced teacher reflected on this practice:

> *I do a lot more partner work now than I've ever done before, and a lot of that's because they're kids that need that one to one help. I don't want them to feel isolated so I say "You can work with a partner on this one, get someone to help" and the dominant partner learns a lot as well (male, primary teacher).* [005]

In the first year of the study another teacher arranged the pairs herself according to ability, with one more capable student as a mentor to the other (after Vygotsky, 1978). This arrangement is shown in Figure 5.3, where the highly-skilled female student is a designated mentor for the boy at the keyboard.

Figure 5.3 Peer mentoring (school H)

In the second year this teacher moved to a freer approach, encouraging more equal collaboration in problem solving:

> *I much prefer having two on, even if they're of equal skill, because they can quite often work it out. They make mistakes and*

> *all the rest of it, but they can work it out together. Which is moving on from the mentor thing, that's even better for them, the fact that they've worked it out themselves. Or they might just need one little push then off they go (female, primary teacher).* [018]

Where students were perceived to have great technical skill than the teacher, the teacher often left them uninterrupted while he or she worked with another group in the class:

> *Otherwise the technology is working against you because you might be trying to take a group somewhere else and keep getting called up to the computer. If the kids can help each other then that's a huge help to me. If they can teach each other on the computer they do a better job than me (female, primary).* [010]

In another school a teacher described the social benefits to students of collaborating to share resources, revealing aspects of her student management strategies:

> *They have become more responsible at meeting deadlines and sharing resources and ideas because it's an immediate need for them. Co-operative work habits, routine access and that sort of thing. If they're not being responsible and they are not sharing resources in the most appropriate way they'll lose a turn and they'll get behind (female, primary teacher).* [013]

Access and equity

Most teachers believed that in the class context access to the computers should be, and was, equitable, like this one, whose focus is on the process and the task, rather than the skill development of the individual student:

> *Everyone gets a shot on the machine. If you're not operating the mouse you're a coach, therefore you're expected to be involved in the process the whole time (male, primary teacher).* [004]

Another teacher believed technology was not just for the *smart kids* or those with prior experience:

> *I don't think computers should be seen as just being exclusive to people who have a computer at home, and kids who have come from a primary school that had a really good IT upbringing. I try to make it as open-ended as I can so it includes everybody and it doesn't exclude the kids, like the normal classroom. With computers some people get a bit scared, like it's only for smart kids, but it should 't be seen like that (male, secondary teacher).* [016]

SOSE and Science teachers in secondary schools in this study were often limited in terms of time and space and generally had to book well ahead to access computers for their students, as these were mainly located in dedicated lab settings, as in this case:

> *It's still so difficult to get into the computer rooms. This one at the start of the year had 12 machines. We've had vandalism with the hub (male, secondary teacher).* [016]

As a result of such vandalism, access becomes more limited, and in two secondary schools numerous signs of this type were observed:

> *Whilst in the computer room students are required to remain seated at the one terminal. No more than 2 students at a computer terminal at any time (sign in computer room, school G, 2001).*

Many teachers also gave students access to their laptop computer as an additional resource. One was asked whether this raised privacy concerns, and responded:

> *Oh I have nothing there that can incriminate. You can't do it in your life because my laptop is used a lot in class. The kids use it sometimes. It's the presentation tool through the projectors; it does all the digital imaging because I've got Photoshop (female, secondary teacher).* [008]

Access to resources is a socio-economic issue that affects students in different ways, and over which teachers have had little influence, although they can address its consequences. Students in schools in this study experienced both high and low levels of access to computers at home, as in these two schools:

> *If they've got one at home or if they're collecting anything, if they're doing anything at home on the topic, we've got to be pretty pleased about that. It's not easy for some of our kids (female, primary teacher).* [010]

> *The difference between here and where I was last year in the northern suburbs, in a very poor area — the difference between what they have access to — technology in the home, what their parents know and can pass on to them, the discussions they have at home. Talk about the gap getting really wide (female, primary Principal).* [024]

Efficient use of time

Because the computer resources are scarce, when students have access to them there is a pressure to work quickly, leading to some tension between speed and efficiency in completing tasks and thoughtful learning (Papert, 1991). It was clear from many of their comments that teachers (and students) expected computer resources to increase efficiency, as these indicate:

> *I like researching with it, I think it's great and it's good to get stuff quickly… So if everything's there and you can do it quickly it makes life easy (male, secondary teacher).* [015]
>
> *I think you get a far quicker result in a lot of cases using learning technologies (female, secondary teacher).* [007]
>
> *Computers are quick. We can find out things we don't know (female, primary student, school B).*

In contrast, following reflection on the management of video-conference segments, teachers lengthened the time available for each group from around ten minutes to half and hour. As a result, one teacher wrote in his journal:

> *The quality of the student video conferences has improved drastically since we began the project this year. The longer time has allowed the groups the time to ask and answer questions, resolve communication and project problems, share and collaborate on projects and give feedback on ideas. This of course makes sense in hindsight (male, primary teacher).* [004]

The greater fragmentation of the normal secondary timetable constrains such flexibility, leading one secondary teacher to comment:

> *With this sort of stuff you need half the time again (female, secondary teacher).* [008]

Where resources were scarce, teachers attempted to manage time on and off computers productively, following Tapscott (1998). In one primary classroom, for example, a table group of four female students was observed planning their individual PowerPoint presentations on paper, writing an outline and some notes while they waited for the computers. In another school, a teacher felt that some students were allowed to waste time, both on and off computers:

> *You wouldn't allow your maths class to play with a Rubix cube for ten weeks but it's OK to muck around for a term with the PowerPoint presentation. I think administrators in schools need to be more forceful (female, secondary teacher).* [025]

Troubleshooting technology

In spite of the provision of technicians across the school system, teachers using computers in the classroom frequently lack timely technical support, and are often less skilled in using the technology than the students they teach. As Drenoyianni and Selwood (1998) found, many teachers spent a great deal of time troubleshooting technology that did not perform as expected, but there was evidence of an attitude among many which indicated that they see this as a part of the real world, and a consequence of trying new ways of working. A range of problems was observed and reported with computers and peripherals, especially where teachers were unfamiliar with the resources, as for example, in secondary schools, where teachers usually share the room with others over the course of a week. Knowledge-building teachers saw these problems as an opportunity for collaborative problem solving, often with students, teachers and technicians working together, and their attitudes generally remained positive, as this teacher expressed in her journal:

> *We've had trouble with some of our Microworlds projects this week. Some of the things students have created that worked one day haven't worked when they've come back to them. Also, some of the students' projects will no longer open. I'm unsure as to whether it was too big or what has happened but we've tried several times and on several computers and nothing has worked. This has meant that these students have to start their project again (female, primary teacher).* [012]

Her colleague indicated that teachers help each other with basic concerns, and call in a technician for more difficult issues:

> *I think a lot of that break down mentality has moved on but I guess that was 3 or 4 years ago, when we were all, as a school, really novices and just getting underway. If the monitor wouldn't come up there would be a panic and there would be a call for the technician to come in. Now we just check our cables and away we go, so we do a lot of problem solving. We do a lot of troubleshooting within the school and we have experts in a whole*

> *range of different hardware and software and that makes life a lot easier. Also having a technician just to deal with those real technical issues makes a big difference (male primary teacher).* [004]

These extracts from observation notes show evidence of the real life approach most teachers take when technology does not function properly:

> *The teacher says: "Right everybody. This is exactly what you don't want to hear. This dirty great big grey thing has gone on strike. Plan B. Given that we're going to have a reasonable quality morning tea what will we do? …*
>
> *Robin, go with [aide] to get the PC laptop, take it to C school, plug it into the network, download it."*
>
> *To a female student she says: "You go and get the laptop off [aide]" and to another group of girls: "You go and get your thing off the file server"(female, secondary teacher).* [008]

Telephones in classrooms enable timely access to support, but only a few teachers in this study had access to a telephone (or Internet chat) while teaching. If they were to have telephones, they believed problems could be quickly solved, as this teacher described:

> *If you had a problem you could ring the other end and say, "What do we do now, we've stuffed up"…I was working with [teacher], he and I aren't fantastic. We didn't know what to do. We had to call someone else and drag them out of their room. If we had a phone we could just ring [coordinator] and he could talk you through it. You could do it via chat, too (male, primary teacher).* [030]

5.5 Teachers manage relationships between people for authentic learning

Where teachers aim to connect student learning with real-world questions and concerns, they need to manage relationships with people within the school and beyond, whether they be professionals in a cognitive apprenticeship relationship (Brown & Campione, 1994), sponsors (Van Eeden, 2001), parents, or other teachers. Creating outward-looking learning communities includes linking between home and school, and with the resources of the wider community (Hill & Russell, 1999). For some this involves a new openness

in the classroom, challenging the teacher's domain. Teachers in this study managed relationships with a range of people within and outside their schools.

Outside experts

Two schools in this study, one primary and one secondary, linked with experts in an apprenticeship relationship conducted online. The secondary school used the expertise of scientists in a project monitoring weather and climate, while the primary school worked on producing creative design products using computers. Finding the experts in the first instance posed a challenge, as this teacher described:

> *We wanted to go outside of the community and then we thought that it wasn't going to happen because everyone was very busy. The kids realised that you had to start close and then work your way out and that was a lesson for all of us I guess. Especially for me, because I was part of that (female, primary teacher).* [022]

With the support of professionals in the local community, the project eventually began. The amount of time required to develop the relationship was substantial, but as the teacher explained, can be a characteristic of authentic activity:

> *Lots of phone calls, lots of emails, lots of letters backwards and forwards. Constantly organising meetings and having to cancel and all that kind of stuff that goes with the community in real life (female, primary teacher).* [022]

Another school used a visiting expert to focus on skill development with students outside normal class times, and teachers valued his contribution although it meant they lost some control over their students' learning:

> *This year they have been extended further through [visiting expert]'s program. A lot of the things that he is doing with our kids are extending them further, incorporating the video cameras, CDs, so we're actually not in control of it as much as probably [we] were last year… We've been very fortunate. He's in great demand. He's got a club that he runs after school (female, primary teacher).* [018]

A secondary teacher reflected via email on a similar idea not yet implemented:

> *I have come across many exceptionally gifted students (with computers). These students, especially the more gifted ones, often find the curriculum uninspiring. They can struggle to complete tasks that are well within their capabilities. Open-ended tasks sometimes help, but because these students are still young they do not always have the organisational skills, task orientation or motivation to complete these tasks. Such students often need to be under the tutelage of industry types with industry standard skills to further their skills in any sort of structured or channelled way (male, secondary teacher).* [015]

Student-student relationships

Teachers also manage face-to-face and online relationships between students to a certain extent, at least while they are engaged in classroom activities. Classes in three schools were regularly communicating with other schools during this study, and although young people are developing their own protocols for online communication, teachers generally expressed a need to control the tone and content of email or chat communications as part of their general classroom management. A city secondary teacher cautioned her class about Internet chat behaviour in this way:

> *Chat with [the country school] people. I don't want to see any nonsense, not calling people hicks or hillbillies (female, secondary teacher).* [008]

Similarly, a primary teacher wrote in his journal:

> *Some [children were] using the email in an inappropriate way. This had to be followed up and investigated (male, primary teacher).* [027]

In the latter case teachers implemented a system of students copying their emails to teachers, which, as another teacher stated *"reduced almost completely the inappropriate email from students"*. [004]

Technicians

Classroom teachers also managed relationships with the technicians who were available to every school in this study, although often on a part-time basis. Technicians were observed setting up and maintaining equipment, and sometimes devised technical ways to protect computer networks from curious students as well as determining rules for

access. Teachers with regular on-site access to technicians expected they would ensure smooth classroom operations, allowing teachers to focus on student learning, as one teacher planning student presentations explained:

> *I will have a technician in on Friday to help me, because if something happens with the digital projector with my laptop then I don't know enough to do it (female, secondary teacher).* [008]

Technicians were also observed dealing directly with students and explaining technical points to teachers. In one case after a teacher tried numerous strategies to stop a printer, a technician fixed the problem, reminding the teacher that access to certain computer functions was restricted as files could be deleted. In a primary school with technical support for two days per week, two teachers described the benefit to them:

> *That makes a big difference because it gives the teachers a chance to teach and to use the technology in their curriculum: not be the tech heads, which most teachers are not (male, primary teacher).* [004]

> *We don't really have the time to do it. We do check the cables and the basic stuff but we don't do the technical stuff (female, primary teacher).* [012]

Coaches and mentors

Teachers in some schools invited people with specific skills to assist in the classroom. These included past students now in secondary school acting as online *masked mentors* to primary students, and *SOSE Magicians* — current students with computer skills —in a secondary school. In one school parents also worked with student groups, as one teacher explained:

> *There are some students who require very tight supervision and direction and do not operate that well in an open-ended environment. This year we have introduced having a parent work each day with one of the groups, helping to keep the students goal directed and on task. It has been an incredibly successful approach (male, primary teacher).* [004]

Although the process of involving others in the classroom is at an early stage, teachers showed openness to such assistance, most often from non-teachers.

5.6 Teachers manage connections across boundaries

Open approaches to the use of time and space are characteristics of a constructivist approach to learning (Cherednichenko et al., 2001) and the spread of technology has led to many predictions that increased flexibility will have an impact on the role of the teacher (Beare, 1998). While primary schools tend to focus on space as a boundary by allocating designated classrooms, secondary schools focus on time, as the day is often segmented into class times in a range of spaces. Knowledge-building teachers are not limited by these boundaries.

The importance of trust

Where boundaries are crossed, relationships between teachers and learners are characterised by trust (Goodman & Goodman, 1990) and at a simple level, this was frequently observed in primary schools, where students moved freely around the school to access resources. For example, a student was observed telling her teacher (rather than asking permission) that she needed to go to the library as she was setting up an international Olympics competition using the Internet. Movement is also common within classrooms in line with a student-centred approach, as this teacher explained:

> *Do they all have to sit in their seat for the entire lesson? Do they work by themselves in groups? Is it a teacher centred thing or is it a student centred thing? I try and do all of those types of things, including geography fieldwork like we did last week. So all types of students have some sort of ownership in classrooms (male, secondary teacher).* [001]

Networked computers allow students and teachers access via password to material on shared drives from numerous points, allowing them to work in a range of settings:

> *Having them networked so that you know if [teacher] has got three kids in another classroom and they are wanting to access their file, they can do that through the network. So it doesn't particularly matter where the children are or who they are working with, they can access their information (female, primary teacher).* [021]

However where individual teachers displayed trust, it was in some cases limited by the expectations of others in the school:

> *I also try to give them opportunities to be independent learners, so they can go away and access the library or computer rooms. A little bit difficult to do that because you are not meant to send students down there unless you pre organise with the teacher, which I find curbs the spontaneity (female, secondary teacher).* [007]

This highlights the impossibility of realising knowledge-building potential without a supportive school culture, which further exacerbates the effects of physical distance from resources.

Crossing structural boundaries

The relationship of one teacher per class was being adapted in various ways in the primary schools in this study. One school experimented with more specialist input — rather than the class teacher covering all domain areas — and found that students valued the change, as this teacher described:

> *It's not enough to attach themselves to a classroom teacher and remain in that classroom. The Year 3/4s said that it was interesting to see that different teachers that were good at particular things were taking the kids for that particular subject. The 5/6s said that they were being prepared for high school, so it was an overwhelming feeling they had at the time that we were doing it to better prepare them for high school and the world. It was interesting to see that the kids were thinking at this level, we obviously don't give them enough credit (female, primary teacher).* [022]

Although there were no formal examples of secondary teachers crossing the timetable boundary, some found ways to relate to students at times other than in class, as this teacher described:

> *I see them, there is a lot of conversations I have with them everyday. Sport is always a good thing. Taking them for extras, you get to talk to them more and see them more. Helping other teachers is always good. I'll come in now and then or go into other classes if I've got a bit of spare time (female, secondary teacher).* [008]

Similarly, knowledge-building teachers are not bound by spatial arrangements. Several made the technology mobile, taking a laptop or data projector to the class where

appropriate, such as this teacher who frequently used her laptop computer as a class resource:

> *My laptop's in the corner. We've got one or two experts that know how to use it. Anthony, if you've finished today I want you to log off and then go over and have a lesson on how you're going to copy your PowerPoint file onto my desktop in readiness for Friday's presentation. Because it's my laptop that will be connected to the projector (female, secondary).* [008]

However this flexibility is not easily managed, as another teacher found:

> *I wanted to run a little data logging demonstration there just for the motion sensor. Because we haven't got the computers fixed in science classrooms, I had to lump over a multimedia projector, lump over my laptop as well, 10,000 leads and power boards and hook them all up and try to get them to work. Then I pushed the wrong key on the bloody monitor so the monitor went off! It took a good 10 minutes to get the thing set up, so that's a hassle. It is pretty demanding on a teacher I think, at the outset, especially if the rooms aren't equipped (male, secondary teacher).* [002]

Another teacher [001] could see the potential for portable technologies such as palmtops, but did not see how mobile phones could fill this need. However, access to portable technologies and computers outside school allows students to cross boundaries of school time and space, as these teachers mentioned:

> *At home you use a computer and people publish and make web pages at home and we can do that at school. So it's more like school's part of the world and we have that global community. It's not that old notion that there was school and they learn stuff at school and they have learned other stuff. It's bringing it together and it's just more seamless (female, primary teacher).* [013]

> *I'm trying to get the SOSE Internet pages up and running and have it so that in the next year or so it's on the Internet. Kids can get a password and log in to access it from home. They'll have their assignments on there so the parents can access it, have the due dates on there so the parents know when things are due. It's three-quarters done (male, secondary teacher).* [016]

Similarly, the mobility of students' living arrangements crosses boundaries and creates opportunities, as well different questions of management, as in these schools:

> *Often we have students, because we are a multicultural community, they go home or back to Israel or wherever. I was teaching a little boy that went to England because his grandma was sick and he was there for two months. Every week I would email him some work, and he would do that and email it back to me (female, primary teacher).* [021]

> *One of the interesting things about our school is the transient nature that has existed for many years. We will have a high turnover by the end of the year, in terms of kids who have come in and who have left again and we have to make allowances for that (male, primary teacher).* [004]

Although several examples were observed in this study, the management arrangements in schools often impede crossing of boundaries, having barely shifted from the arrangements of the twentieth century.

Discussion

Bearing in mind the nature of the development of the propositions above (as described in Chapter 3), the findings of this chapter indicate that it is likely that knowledge-building teachers:

- involve students in management
- encourage student motivation through intrinsic means
- model collaborative knowledge-building and management practices
- manage technology as a resource for students to build knowledge
- manage relationships between people for authentic learning
- manage connections across boundaries.

Teachers in this study managed the learning environments in a range of ways, from an emphasis on student autonomy to high levels of teacher direction, from collaborative to individual management and from loose to rigid conceptions of time and space. The whole school leadership and management culture and the provision of resources influenced all of them, but not all felt that they could influence the context, particularly in individualised cultures. Hence the practice of management was mainly conducted at the classroom level, with an age-graded group of students, and modifications towards

knowledge building generally took place within this structure. Teachers were rarely observed attempting to manage the whole class as one group, but organised students into pairs or small groups and dealt with them at that level.

Many of the findings in this chapter echo those of the previous chapter regarding designing the learning environment. In many classrooms, for example, teachers involved students in the classroom management practices and in making decisions regarding their own learning, such as who to work with and what technology to use. This practice appeared to encourage flexibility and had the effect of motivating students intrinsically. In fact motivating students is now more likely to be less of a role for teachers than in the transmissive classrooms described by other researchers (Dexter et al., 1999; Jackson, 1990). While some teachers report an extrinsic motivating effect of technology for boys and girls, this might be due to the capacity for students to manage their own tasks (whether due to teacher trust or teacher ignorance) and is unlikely to be sustained as computers spread and lose their novelty value.

In terms of teachers' management practices, the findings suggest that modelling of collaborative practices is likely to enhance knowledge building, both within and across schools, although like collaboration in design, it is much more common among primary teachers than their secondary colleagues. Leaders model for teachers and teachers for students in a cascading effect. However in spite of the opportunities technology provides for collaboration this is an area of novelty, with accompanying concerns among teachers about how to manage a free and open flow of ideas in a professional context. Managing technology itself is an area that occupied a great deal of time and intellectual energy for the teachers in this study, and it is in this role that the changes in both the classroom and the social context have an enormous impact. First, managing access to scarce computer resources, whether within the classroom or externally in pods or labs, is a matter of constant concern. Teachers in this study held underlying beliefs regarding fair and equitable access to computers, and attempted to arrange this in varying ways which often involved student collaboration or at least, sharing computers, and sometimes giving students their laptop to use in class. Some allocated or rationed the resources while others used the principle of *on demand*. Over the course of this study many

teachers changed the arrangements within their control in an attempt to find solutions. The levels of control differed, generally as the location of the computers differed, and this was generally a primary/secondary demarcation. The levels of technical support also differed in different schools, often depending on size, so that students were called upon to assist. Managing the functioning of computer equipment is extremely important in a classroom operating on just-in-time access, as it is in a lab which has been booked weeks in advance. Although some teachers in this study claimed that they were now able to deal with computer problems themselves, they were also pushing forward into new uses that required telecommunications capacity beyond their control.

The findings relating to boundary crossing (5.5 and 5.6) show aspects of teachers brokering relationships across the boundary of the classroom community, and students crossing boundaries of time and space. As increasing numbers of people are required to support classroom projects, teachers are involved in human resource management. Finding outside experts and maintaining relationships with them, and liaising with technical support staff, parents and researchers means that for teachers the concept of classroom management is less likely to means a focus on student discipline issues than in the past. Discipline problems were rare in the classrooms observed, perhaps due to the self-management of students described above. The atmosphere of trust, inherent in boundary crossing, is also likely to support positive student behaviour. Students in many schools were encouraged to move around the building and to access material from computers and other resources in many locations, although in secondary schools this was managed more rigidly than in primary schools. Where mobile technologies were available some teachers used them to advantage, while, for others the arrangements were difficult in the time available. Mobile phones were not observed in use, but they raise an interesting prospect, perhaps challenging teachers' trust and flexibility in the future. The major boundary of one teacher having responsibility for a class group was also crossed in several primary schools, although generally there was only one teacher with a class at any one time.

The potential for knowledge management with technology was rarely exploited, due in part to limited system capacity. Most teachers used servers for short-term storage of

information and student productions, but they did not raise the issue of long-term knowledge management. For some this could be due to the concern that products, as well as ideas, need to be perfected before they are published, an attitude which works against the openness and free flow of information required of a knowledge-building community.

In terms of their capacity to enhance knowledge building, the range of teachers' managing behaviours constitutes a zone of proximal development, which provides some guidance for professional learning. Most teachers in this study saw the classroom as their domain of management, and made decisions at a micro-scale with their students rather than with other teachers. Collaborative management was more evident in primary than secondary schools. There appears to be potential for sharing many more management tasks across the staff, such as by allocating specific responsibility for external liaison, supporting teachers with skilled technicians, relieving teachers of detailed technical tasks.

The previous chapter indicated that the role of designing the learning environment is important in establishing a context for learning, thereby influencing other roles of teachers. The findings of this chapter indicate that management of people and resources is an important and time-consuming activity which also impinges on and interacts with other roles, particularly influencing the time available for the teacher's role in mediating student learning, which is considered in Chapter 6.

Chapter 6 : Mediating student learning

This chapter focuses on the data that relate to the third role of teachers: mediating student learning within the designed and managed environment. The mediating role is that which provides an intermediary in the learner's quest to make sense of human experience. As the review of literature showed, the role includes the aspects shown in Figure 6.1: instructing, demonstrating and coaching, monitoring and assessing, and reflecting on learning.

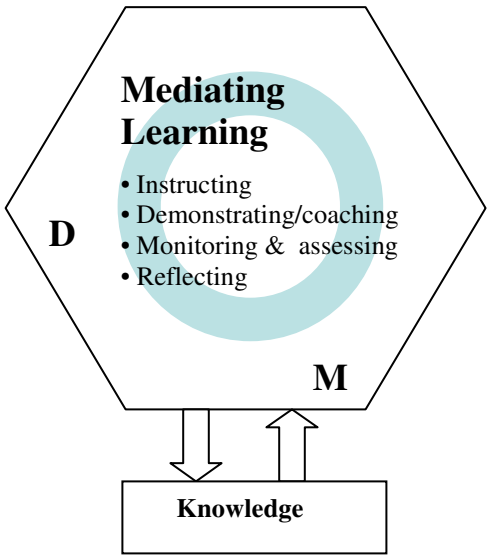


Figure 6.1 Mediating student learning

Laurillard (2002) explains mediation as the process of turning experiential knowledge into formal knowledge. Vygotsky (1962) suggested both adults and peers could mediate an individual's learning, while more recently Denis (1997) suggested that the teacher is but one of the mediators in a vast array of multimedia influencing learning. Nevertheless, teachers as mediators add value to the learning experience by helping learners to develop their ability to use new knowledge, to change the pattern of their previously acquired knowledge (Goble & Porter, 1977), to make links between existing and new knowledge (Jones et al., 1995; Selinger, 2001), to make personal sense of the ways in which claims about knowledge are generated and validated (Driver et al., 1994) and to challenge existing constructions (Freire, 1993). Clarification of this role, assisted

by developments in our understanding of learning (Marzano, 1992) is important to the future of teaching as a profession (Crook, 1994). Rather than stepping back to allow computers to take over the role, Moll (1990) suggests that teachers should develop new forms of mediation to take the practice of teaching forward. Further, the research indicating that the quality of teaching and learning directly affects student progress (Hill & Crévola, 1997; Wang et al., 1993) makes it important to find ways in which teachers share their knowledge of mediation and collaborate in the practice.

Mediating includes ways to encourage discovery, guide participation and engage in reciprocal teaching (Brown & Campione, 1994), to help students to refine their problem-solving strategies, and ultimately to learn how to learn (Jones et al., 1995). Teachers become keen observers and students of their students, adjusting the level of information and support as required (Jalongo, 1991) and scaffolding the task with structures that will be removed as the learner progresses (Mercer & Fisher, 1998; Wood & Middleton, 1975).

Eight propositions about mediating learning —based on the data and supported by the literature — were developed and are presented as headings in the following pages. Teachers are identified by gender, school type and identification number.

6.1 Teachers help students learn how to learn

The practice of teaching is based on knowing about learning, and teachers using a constructivist approach assist students to act, observe, and reflect in order to evaluate and improve their own learning processes (Brown & Palincsar, 1989), as one teacher expressed:

> *It's to provide the support that they need to become independent. They learn how to learn (male primary teacher).* [006]

Where teachers in this study used particular learning resources in designing the curriculum, they were sometimes observed to articulate and discuss them with students in both theoretical and practical terms. Classroom discourses included the individual learning styles and multiple intelligences (Gardner, 1999), and the use of metacognitive terms and strategies.

Understanding self

Student-centred teachers began with helping students to know and articulate more about themselves. One primary teacher described how she encouraged students to continually set themselves questions and goals as well as reflecting on their learning path in relation to a broader context:

> *"How can I maximise my potential? What are my learning styles? What's my intelligence, dominant intelligence? What am I great at?" And recognising therefore what they need to develop metacognitive skills. For me that's getting them to be responsible enough to recognise that you are a learner and you are going to constantly challenge yourself, set goals and reflect from where you've come… So helping kids to get to that point where they can examine their learning in a context of me as a learner and the whole world and the big picture (female, primary teacher).* [013]

To support her theoretical stance she created a symbol —Max the doll —climbing up the ladder to more complex thinking as a visual prompt (based on Bloom's Taxonomy):

> *We want them to 'max out' their thinking. So the kids here really love Max, now climbing the ladder and he's making his way up to the…synthesis level, which isn't up there yet. But they love it when Max goes up a rung. It's a good symbol (female, primary teacher).* [013]

Reflection

A pause for reflection is often a starting point for metacognition. In primary classrooms, teachers commonly used a whole-group reflective discussion at the end of the day for various purposes, both personal and social, as one teacher explained:

> *I think it's a way of tying together what we have been learning. If the children just do their stuff and go, then there's not a conclusion for them, but if we come together for that share time, it's a way of them verbalising and consolidating what it is they have been doing. They can also share their knowledge with other students, which might actually help other people (female, primary teacher).* [012]

Some teachers used reflection at the end of a day as a bridge to connect students with their parents, preparing younger students to respond to the question "What did you do at school today?" Teachers were observed encouraging students to use prompts such as de

Bono's Six Thinking Hats (de Bono, 1992, 2000) in their reflection to identify things that went well, problems, feelings and so on. Such end-of-session reflection was observed less often in secondary classes, and when observed, tended to be more about organisational matters than learning processes, as this teacher explained:

> *I do this at the end because I can pick up kids that I've missed during the class. They will often voice... at the end," I can't do this, I need that". That's an opportunity to do it then, and it keeps me in line. And we have no more SOSE classes. We only have three a week, so that's a problem (female, secondary teacher).* [008]

Teachers also encouraged students to write reflections on their own learning, particularly in primary schools, where some teachers included weekly reflection in learning journals for students as an integral requirement in projects. In one case, a set of guiding questions was provided, and journals were completed on the computer and submitted to the class teachers. The questions included:

> *What did you do well in the project this week?*
>
> *What have you learnt from other students this week?*
>
> *What is something new you tried in the classroom this week?*
>
> *What did you teach someone else this week? How did you feel?*
>
> *What did you learn this week? Who taught you and how did they do it?*
>
> *What have you learnt about computers or software programs this week?*
>
> *What difficulty or frustration did you experience this week? (curriculum document, school C, 2002).*

While many teachers agreed, as indicated in the previous chapters, that students should be responsible for their own learning, there were relatively few examples of teachers articulating the processes of learning. Where teachers used the multiple intelligences in designing tasks in secondary schools, for example, they did not report discussing these intelligences with their students.

6.2 Teachers share teaching and learning with students

In a community of learners, teachers are co-learners with their students (Directorate of School Education, 1994; Ministerial Advisory Council on the Quality of Teaching, 1997) while students are at times each other's teachers (Brown & Campione, 1994) and even teachers of the teacher. In such a community everyone needs to know how to teach and how to learn, to be both an expert and a novice. Modelling teaching and learning involves thinking aloud to show ways of learning as well as demonstrating skills and processes (Jones et al., 1995; Russell, 2000), sharing personal meaning and articulating uncertainty. A process of teaching-and-learning (Mercer & Fisher, 1998) results.

Co-learning

While teachers in the study held a range of perceptions about the appropriate teacher-student relationship, the prevailing view was of a partnership, as articulated by this teacher, who used the structural metaphor to delineate the community of practice including teachers and students:

> *…it's developing a partnership with the kids saying, "We are learning this together. We've got a framework in which we are going to learn this stuff and there has to be some kind of rules and fences around that. But within that we are learning together". And I think that's the thing that we have developed very well in the school (female, primary principal).* [023]

In terms of teaching and learning, this view can sound rather laissez-faire, perhaps even devaluing the important role of the teacher, as in this comment:

> *It's not so much me teaching them, it's just a sharing of information and knowledge as needs arise (male, primary teacher).* [003]

As Jarvela (1999) found, this new relationship between teachers and students represents a change in attitude to status and behaviour for those who have been teaching for many years and were generally trained in transmission models based on differential power, like this primary teacher:

> *That's all I did, was to instruct…I'm not at all threatened by not knowing. I used to be really threatened by all that, but I'm not at all now (female, primary teacher).* [018]

Other experienced teachers, who had changed their method of teaching to become co-learners with the students, commented on the shift in power and were enthusiastic about the change:

> *Being a co-learner is just empowering for me. Kids love it and it's more natural (female, primary teacher).* [013]

> *I find it really stimulating that the students then become my teacher, they teach me things and that's what I found very beneficial. That relationship between the teacher as the provider of the information, the student as the person who absorbs it or learns it, that's completely changed. Everyone is just a learner and engaging in some sort of exchange, which I find excellent. I think some of the most interesting things I have learned about using computers, given that I would describe myself as an early novice in the area, have been things that kids have shown me (female, secondary teacher).* [007]

In a thoughtful comment another experienced teacher, as yet less comfortable with the change, reflected:

> *So what we need quickly really is an expectation of ourselves that isn't as great. That it doesn't matter if we don't know the answer…It's like when you're sharing a big book with them and you make a mistake as you're reading. They see you going back: you've actually modelled (female, primary teacher).* [010]

Modelling teaching and learning

It does appear that introducing computers has made teachers aware that they have much to learn in some areas, and this could have some influence on their theories and practice of teaching (David & Shields, 1991; Fisher et al., 1996). But although at times some teachers appeared overwhelmed by their lack of skill with computers, and relinquished their role, knowledge-building teachers were not afraid to be experts at times, as was this teacher:

> *Sometimes I am an expert compared to whoever it is I'm showing (female, primary teacher).* [010]

Others believed too, that teachers have a particular expertise in the processes of learning (Brown & Duguid, 1996), which this teacher referred to as *tricks*:

> *We freely admit that we're not going to know everything and we want the students to push past us. In a constructivist learning environment this is a natural thing. We don't set ourselves out to be high and mighty know-it-alls because we know full well that we aren't. However we know the tricks as teachers to help students engage in their learning (male primary teacher).* [004]

In a classroom community of practice the teacher is simultaneously expert and novice, moving from the periphery to the centre depending on circumstances, as are the students. This role sharing requires the trust identified by Goodman (1990) and leads to exploration and healthy risk taking. Some teachers actively modelled teaching and learning with their classes in various ways. In one school, a teacher described how she worked with students as a teacher and co-learner in programming a shared project:

> *We were flying by the seat of our pants, in all regards, and it was my job basically to teach children Microworlds. That was a program I know nothing about, so I was learning from the manual, sitting there giving instructions on how to animate text. Then we were working backwards in a way, because they'd have to then look at the procedures and see, "Oh this is how it was written in Logo language" and then they would modify that to suit their needs. It was a lot of experimentation, exploration, and starting from something really basic. Then the kids would go off and discover new things for themselves and they'd teach each other, they'd teach me, they'd teach their teachers (female, primary teacher).* [028]

This teacher comes very close to describing the active nature of play (Kane, 2000) in her use of terms such as *experimentation* and *exploration*. On school C's web site another teacher had written an article about her experience of students in the early years learning through serious play (Parsons, n.d.). However while many teachers encouraged the concept of exploration, the word *play*, with its link to games, was associated pejoratively with computers. One teacher described his perception of students new to the school:

> *They start talking about computers and they talk about "playing on them" and our students look at them and say, "What are you talking about? We don't play with the computers around the school, we use the computers for their own good and to learn. They don't do much in the way of games at all (male, primary teacher).* [004]

Cooperative learning and peer teaching techniques

Teachers encouraged student learning through peer collaboration and were happy to share the mediator role with students, sometimes through scaffolding techniques (Brown & Campione, 1994). One teacher established a formal co-operative learning technique, giving these written instructions:

> *Once you have completed your research then your Expert Group responsibility comes in. You are to reform into 6 groups, with a representative from your group going into each of the other Topic areas, i.e. one A, one B, etc and report to each other what you have learnt (unit outline, school F, 2001).*

Later she described in conversation how the knowledge they created would be shared with the whole class through presentations:

> *There's eight groups and they are all looking at Antarctica. We did a jigsaw [co-operative technique], roughly but it worked out in friendship groups. They're looking at animals, flora and fauna, exploration, so they will then stand up at the end and talk (female, secondary teacher).* [008]

She also articulated her reasons for having students teach each other:

> *I also encourage cross fertilisation of ideas, so that those boys who did the sound file stuff… a way to reinforce what they've learnt is to get them, to teach, say, the girls. They know something and they pass it to somebody else: it makes them proud of what they're doing (female, secondary teacher).* [008]

In a primary school, a teacher reflected that allowing *extra time* for students to interact during peer teaching improved the quality of the mediation:

> *I was proud of my students as they were able to guide, instruct and share with their team members at [other school]. I think giving a little extra time during the video conferences and making sure that the mentors know how to use ICT effectively and how to act as teacher/mentor during the process makes for a better conference (male, primary teacher).* [004]

These comments reflect the benefits of collaboration to the group, as indicated by Slavin (1990), and to individual self-esteem (Cherednichenko et al., 2001).

However, collaboration between students was not universal in this study. One secondary teacher reflected on the students' expectations of teacher direction, in spite of her own beliefs:

> *I don't think students have enough of an idea of recognising the impact that other students can have on their own learning. They see the teacher as the provider of the classroom activities and they don't listen as closely as they could to other students. They don't use other students to get feedback on their own ideas, or exchange ideas. Over the whole school it is very teacher driven (female, secondary teacher).* [007]

Another disagreed with the practice of students mentoring or teaching others, and explained why she found this approach problematic:

> *It devalues the teacher and it's not right for the kids. I mean it's better to have 50 or 40 kids in the room and two teachers. One who's able to work with the kids who need some extension, rather than one teacher in a room and kids helping other kids while the teacher wanders around not doing anything… I've heard a lot of people say proudly how the kids that are experts spend their time helping other kids and I'm thinking "What else could they have been doing?" and "Why didn't you send them off with another teacher to continue to extend themselves?" It's a real problem for me (female, secondary teacher).* [025]

6.3 Teachers and students monitor and assess learning together

The processes used in monitoring, giving feedback, assessing and reporting on student progress give powerful indications as to what behaviours and knowledge products are valued in a community (Papert, 1991). Assessing student output and outcomes is a powerful role, most commonly vested in the teacher, but clearly able to be undertaken by students. Formative assessment practices are continual and recursive, unlike the summative practices of allocating marks, but in this study both are most likely to refer to the student as an individual contributor to group products, rather than attempting to assess group processes and products globally. Clarifying and making explicit the purpose of assessment is important, just as it is for learning tasks as discussed in Chapter 4.

Assessing outcomes

Although assessing students' progress has several purposes — including identifying prior knowledge, diagnosis, and evaluation of task suitability — in a world dominated by measurable outcomes, teachers feel the pressure to provide evidence to a broader audience than students and their parents that they are achieving in their own role, as this teacher expressed.

> *We're being asked questions by business and by the wider community and they want to see outcomes. We need to be able to articulate this now and then evaluate it (male, primary teacher).* [004]

Schools are also often asked to justify the high investment in technology in relation to student learning outcomes. In view of this a principal commented:

> *We don't know how we can prove that it improves student outcomes, but we are very convinced that it improves engagement, higher order thinking skills, the work skills of the teacher and the work skills of the next generation (male, primary principal).* [032]

Monitoring progress

Most teachers in this study saw monitoring student progress as an integral part of classroom activity and ongoing assessment, and devised a range of ways to do so. One primary teacher indicated:

> *I think a lot of it is from anecdotes and discussions with kids and knowing that they can articulate what they are doing in relation to a learning path (male, primary teacher).* [003]

Another explained that some teachers use a mental matrix:

> *Teachers using technology are constantly on the move, their eyes are roving the whole time, they're watching what's going on within a room. They're plotting either against the matrix — or in their mind if the matrix is embedded in there — where the students are at and where they need to go (male, primary teacher).* [004]

One structured way of monitoring is the classroom conference between teacher and student. A curriculum document described the process in one school:

> *In general the students work on the project for a term. The teacher conferences throughout the term and the students work on the different stages. Children have a project proposal to complete and share with the teacher at each conference (curriculum document, school B).*

Where student work was stored electronically on a server, or drafts submitted in digital form, teachers had access to work-in-progress and could make written comments electronically. Teachers also monitored and evaluated the tasks and the interaction during lessons in an ongoing way to ensure that they were appropriate for the individual or group zone of proximal development, as this teacher described:

> *If I'm looking at ways of measuring the quality of teaching and learning then I'm looking at students and whether they were engaged in the task. If they're not, then I think that lesson wasn't very good because they weren't as engaged as I'd like them to be, so we need to try to work out ways that we can improve this for them. Often if they're not on task it's either been too difficult or not appropriate or not relevant (female, primary teacher).* [010]

Jackson (1990) claims that teachers today stress the positive aspects of behaviour and learning and tend to overlook the negative, and this was evident in the classrooms observed. A secondary teacher reflected on the output of one student:

> *If I ask Les to do anything in his workbook, 9 times out of 10 he won't do it. But when I asked him to produce a newspaper on a tropical cyclone, he did that, he was fine. He was totally pre-occupied in class, doing what he had to. Now the quality of what he actually wrote — if I was very critical — a lot of the background information he hadn't collected, because he didn't access any of the other sources of information. He hadn't done that, but then again, he actually had a printed out a cyclone newspaper, he used Publisher, he downloaded some images, he used Spell Check. All of those things are something he would never have done if I had asked him to do it in his book, so the fact that he hadn't actually done the task the way I asked him to was incidental (female, secondary teacher).* [007]

A teacher in another secondary school explained her acceptance of certain levels of output was a consequence of allowing exploration:

> *When the PowerPoints present you'll probably see the boys will do that bullet one — ch ch ch — they'll have everything flying*

> *across. The text will be over there and you'll say "What was that?" Well it's your first PowerPoint assignment, that's what it is, and the next one gets better (female, secondary teacher).* [008]

Other teachers are in unfamiliar territory when presented with the products of open-ended, authentic tasks (Carr et al., 1998) or of software unfamiliar to the teacher (Heppell, 1993). One teacher commented:

> *I have children who are doing things that I have no idea what the program is. I don't know anything about it, but they are producing stuff on that and bringing it back and sharing with the kids (male, primary teacher).* [003]

Yet another was quite critical of teachers' inability to discriminate:

> *…when they see some technology that they think is pretty gee whiz. I've seen that a lot too. They've made a series of slides and they've made a video but there's nothing behind it. You know, it's a show. That's all it is in terms of the thinking behind it, and you know as a teacher there is nothing there, it's as thin as thin (female, secondary teacher).* [025]

Authentic assessment

Authentic assessment forms such as portfolios were used in several primary schools in this study, both as a means of long-term formative assessment and a link between school and home. In one school, large scrapbooks were used to presents evidence of student achievements:

> *Our work samples, our portfolios are such a picture of the kids' development that you would see technological aspects all the way through it. Not just say "Oh go and do an Excel graph so I can stick it in and show that you can do Excel" but you would actually see printed work that they had produced and research that they had gained (male, primary teacher).* [005]

In another, students' digital projects were recorded to videotape portfolios as their parents were thought to have better access to video players than computers. A teacher described assessment procedures:

> *A lot of sampling of core learning stuff, dictation samples, stuff to put into portfolios, but, annotated with the outcome that was targeted and the annotation which indicates how they have gone.*

> *So it's really assessment tasks rather than just testing (female, primary teacher).* [013]

A third primary school had commenced developing digital portfolios which valued knowledge objects and could provide secondary teachers with a glimpse of the student's prior experience, as the Principal described:

> *The audience can be a number of people. Hopefully the parents, number one. I'd like Year 7 teachers to be a real audience. It's not going to cost much to burn a CD and send it off with the children to their schools for them to have a look at what they've done and who they are, over the seven years (female, primary principal).* [024]

In yet another primary school, a teacher established web-based archives of student products, and explained their purposes:

> *Well we can archive it, so the teacher for next year can use it. We've already got it set up, which will be very useful for parent-teacher interviews (male, primary teacher).* [019]

Peer and self assessment

Peer assessment represents student involvement in decision-making in the classroom in various ways, including in some cases the development of criteria and rubrics, self-monitoring against these, and judgement of the work products and processes of others. Peer assessment was observed in informal ways, such as through oral questioning and feedback after a presentation, and in more formal ways where students gave marks to the projects of others, based on published criteria. One teacher explained how the process was ongoing and recursive, as students learnt how to read the system:

> *We've actually developed a criterion so they all know what we're looking for in the report, and I get all my kids to come up and give an oral presentation on their projects. They have to actually talk about where they got their information and why they did it a certain way. They're presenting their project to their peers I guess, and their peers are looking at the presentation, how they went about it, more the process and the quality of their writing. So once they know that, their oral presentations get longer and longer, as they include more and more, so they get a better mark (male, primary teacher).* [019]

Another merely set the technical ground rules for a class assessment activity at the beginning of a class, as PowerPoint presentations were about to begin:

> *Now it's not a popularity contest. It's actually something that you're doing you're assessing you're giving your opinion about somebody's presentation. I'll just go through the criteria. Content: actually what's in it. Secondly, did you find that presentation interesting? Third, the use of technology: did you think that person's use of technology was appropriate? Fourth, organisation: was the person well organised? And fifth I'll call it the overall package. Now you circle each of those from 5 to zero, you give it a score out of 25, and what I'll be doing, I'll be giving it a score, and it will be interesting to see what my marks are, as compared to the class as an average, so I'll actually average them all out (male, secondary teacher).* [001]

In Figure 6.2 a team of Year 5/6 students is presenting their product, a computer-controlled model car, to other teams and the teacher. They explained (using the large screen monitor) how they developed the program in Microworlds, showed how the car operated, reflected on the way the team worked, and answered questions from other students and the teacher. The car was to be entered in races with another school. During the presentation the team could see that there was further work to be done. Throughout, the teacher assessed the project and made notes on his laptop computer.

Figure 6.2 Peer assessment of Microworlds project (school C)

Two other primary classes were observed completing student self-evaluation forms (based on a word processing template) whereby the students reflected on the progress they had made in the past semester. In yet another school, the Principal explained that self-assessment was one of a range of strategies and documents used:

> *We include in our assessment here self-evaluation that they take home with their reports. They have to complete an evaluation of their work as well… Now we are looking at different strategies, we're looking at peer assessment, self-assessment and reflection, in terms of the teacher and the student talking about what they've learnt (female, primary principal).* [024]

Individualisation of assessment

The individualisation of assessment and reporting to parents stands in contrast to current moves to encourage collaboration and group products (Kaye, 1992), but change requires teachers, students and parents to agree. This can be difficult in a competitive environment, particularly in secondary schools, evidenced by one instance where two boys were observed asking the teacher to mark their joint PowerPoint project and presentation separately. Several teachers in this study have made attempts to show that they value collaboration, by including explicit criteria in assessment rubrics or through class reflection times. One teacher explained how she focused students' attention on these social competencies:

> *I get the kids to assess themselves: their own performance, the performance of the group in terms of time management, sharing resources, offering ideas and staying on task, in terms of all those other spin-offs… And from that comes, "Well okay, we have recognised this about yourselves, now what are you going to do about it? What are you going to try to do better next time, how would you do this?" (female, primary teacher).* [013]

In most schools in this study student assessment and reporting is limited to age-grade levels, and teachers in only one primary school were prepared to be less rigid. Most teachers used the CSF II document as a basis for recording individual student learning outcomes, while some also recorded unplanned or unexpected outcomes, a practice that has the potential to link across Key Learning Areas, as this teacher described:

> *That [CSF] is a document that will help facilitate. We're certainly not hung up on having to meet every outcome and planning to that outcome. It's a framework and how we facilitate our learning, and often you can do things and then you look at it and go "I didn't anticipate on covering this", but you have done it anyway. And it's about tapping into how the children are reacting and being very fluid (female, primary teacher).* [021]

However the management consequences of this when crossing the boundary from primary to secondary school were also raised by this teacher:

> *We as a school are more than confident to have a child consolidating at Level 5 of English. But when they go to Secondary Colleges they will say "Hang on a minute. Level 5 is for Year 7 and 8" and sort of boxing them in, whereas we are more open to "Ok this is where the child is at and let's target a program to where a child is at". If we have twenty-six kids in our class and they are all at different levels then we will teach them to their levels (primary teacher).* [021]

Conversely, where one primary school had changed its organisation to give responsibility for a large group of students to a team of teachers, they realised that their assessment and reporting practices would have to change, as this teacher explained:

> *It's going to change this year because having nine different teachers looking at 200 kids you need a new format. How you see the child is completely different to what they're like with me. Then again how they behave and how they interact and how they perform in PE might be completely different to how they are going to carry out those things in an art session using a computer. So we all need to sit down before report time starts and get a new thing happening (female, primary teacher).* [022]

While secondary teachers would recognise this as their usual practice, it is interesting to note the more holistic perspective of the primary teacher saying *we all need to sit down.*

6.4 Teachers build on students' prior experience

Within the constructivist approach, the prior views and perspectives of students are a basis for their learning (Goble & Porter, 1977; Jones et al., 1995) and knowledge building takes place when learners make links between existing and new knowledge (Selinger, 2001). Students create their identity from this base. This means that experiences outside the school, including the culture of the home or family, and the input of peers, the media and recreational activities, must be valued by teachers and

peers (Damarin, 1996). Increasingly for teachers of middle-years students in secondary schools, it includes making links and building on students' primary school experience.

Acknowledging teachers' attitudes and students' experience

Teachers in this study generally acknowledged that students wanted to learn, and that activities should relate to their lives, although they had differing means and various levels of commitment to this aspect of knowledge building. They also revealed some stereotypes in their thinking. These teachers reflected a common view:

> *I reckon that kids really love learning, even if they're the most tearaway disinterested-looking kid. But it's got to be something that has a relevance for them, or presented in a way that they'll get something out of it (male, secondary teacher).* [015]

> *Sometimes kids have got some things from outside — influences — they don't come into the classrooms as blank pages. There are other things that are there with them, they could be negative influences sometimes (male, secondary teacher).* [002]

The means by which teachers identified prior experience were generally informal. A primary teacher gave an example showing that some perseverance on the part of the teacher is often necessary to identify prior experience, interests and perhaps even prejudices:

> *It's just finding what each child is interested in and what sparks their imagination and excitement, and heading in that direction. For example, we are doing a unit of work on Koorie [aboriginal] culture at the moment and at the start of the year I had some children that said, "I don't care, I don't want to know anything". We talked about all the different aspects of the culture and then sure enough there was something there, that wow, got them, opened up that door — houses — but there was something for all of them, that they were really interested in (female, primary teacher).* [012]

While the prior experience of many students includes a great deal of technology, many saw *educational* uses of technology as separate from other uses, and many references to computer games by teachers in this study were negative, reflecting their view of play

mentioned above. This teacher was typical when he described out-of-school computer use:

> *I think the other aspect of it —whether you would say it's becoming more educational — would be that they would show evidence of bringing stuff from home from their home computers, because they spend so much time on their computer but purely for games, know what I mean? But then they start bringing things from home where they've gone into web sites…that we've suggested for the Olympics. They start bringing stuff in like that and we'd say "Hey, they're really using it for their own learning, for their own growth" (male, primary teacher).* [005]

Girls are said to use computers less often outside school than boys (Carey, 2002; DETYA, 1999), thus reducing their prior experience. Gender stereotypes can also influence a teacher's knowledge of prior experience, and in these examples from two secondary teachers it is not clear whether the teachers' prior views or the students' attitudes were at the forefront:

> *I think probably with the girls, they [computers] might even disadvantage them sometimes. Just in terms of their presentation. Because I think with girls they probably they enjoy doing the poster paper more, they like putting in the effort, the time to make it look good. Computers rob them a little bit of that opportunity. So the thing is if they can transfer that sort of skill into the technology side, then that comes across (male, secondary teacher).* [016]

> *Boys tend to specialise a bit, they might go for the computer languages, or want to find out all the nuts and bolts about the computer, whereas girls are more happy to look at the assignment and try to do it creatively. They might approach it differently (male, secondary teacher).* [015]

The primary/secondary split

As the boundary between primary and secondary schools remains strong, secondary teachers expressed difficulty in knowing and accommodating students' prior experience in primary school. Some teachers focused on their experience with computers:

> *I think there is such a great range of expertise with technology, it's very hard. And I must admit I probably, falsely, had the*

> *perception that most kids would have a minimum standard coming from primary school. In fact the difference in the level of technology is probably more marked than anything because you have got the kids that have had technology in primary school, you have got the kids that have their own computers, but you have got some people who have done none of the above, at all. I must admit with this class, that's the thing that's amazed me thus far (male, secondary teacher).* [001]

> *One of the drawbacks, I've heard from quite a few people, is that the kids have gone on to secondary and they've had to do backwards steps because they were so far ahead. That's a concern (male, primary teacher).* [031]

Another secondary teacher guessed at prior experience and focused on engaging his students in a general way:

> *You really are dealing with an unknown quantity I guess, in terms of the individual needs. So you sort of just tend to pitch to the middle, and make the work interesting enough for the more challenging students and hopefully pick up the weaker ones as well (male, secondary teacher).* [016]

Both primary and secondary teachers raised the gap between the broad communities, structures and discourses of primary and secondary schools on several dimensions. Two teachers analysed the difference between the types of school culture in terms of student autonomy and leadership:

> *It really does seem sad that you get the [Year] 6s to the point where they are really, really responsible and they are just firing on all four cylinders and then they have their wings clipped and they have to conform and they are told things, rather than them being allowed to be the decision makers in the learning (female, primary teacher).* [013]

> *We baby them and bring them back to an atrocious level when they enter secondary school. We really do, we baby them and honestly we take responsibility away from them. We start them off again if you like, they're like prep again and it's terrible. You get kids who have been members of junior council who have been mediating disputes between kids. They come up here and they are suddenly nothing and no one. So I think we need to learn from our primary colleagues. Primary teachers have a way of dealing with kids and a way of speaking and questioning kids that is very different from secondary (female, secondary teacher).* [025]

This lack of connection also has implications in terms of engagement. Wenger (1998) suggests that it is more important for students to have experiences that allow them to take charge of their own learning as described in Chapter 6, than to cover a lot of material in the curriculum, yet primary schools tended to focus on the former and secondary schools on the latter. In only a few instances were teachers acting as brokers between the two cultures.

6.5 Teachers facilitate connections between people

The concept of the school as a society or connected community underpins social constructivism, and Vygotsky (1962) emphasised the importance of learning through everyday activities in a holistic and situated way, rather than focusing on sets of disconnected skills. Teachers working towards knowledge building connected with students and connected them with others.

Social connectedness

Teachers in both primary and secondary schools valued social connectedness and saw that they had a role to play in students feelings of belonging, as these teachers expressed:

> *I think that's also important as well, life shouldn't, school shouldn't just be about books, it's how you interact with other people, other people in your class, peers... (male, secondary teacher).* [016]

> *I mean we all live busy lives, but you may be their one stable adult in their life, so it's just taking time. It might be five minutes, it might be two minutes just to have those incidental conversations, making it personal, letting them know that you actually know about them (female, primary teacher.* [021]

Wenger (1998) argues that newcomers and old-timers should be engaged in shared practices, not only for purposes of transmitting cultural heritage, but also for the mutual negotiation of identity. While few teachers raised this, one secondary teacher spoke of the mediating role of the teacher working with students to make sense of technology in a generational encounter:

> *Teachers offer the opportunity to create a space in which students can discuss issues around technology. They are a person who is able to mediate discussion, they're a person who is able to*

> *talk about ideas, they're able to talk with students about the future and the past, so they're able to put use of technology into context. They're able to work with kids about the best ways to use and manage technology and also how to deal with the new ideas (female, secondary teacher).* [025]

Teachers operating as brokers are able to make connections between communities of practice over time and space, but in the following exchange with a student discussing his progress, the teacher missed an opportunity to make a connection:

> *Teacher: You've improved in your reading and your maths. It might be because you've been doing that Bridges program. Don't you think you've improved in Maths?*
>
> *Student: Because it's in Sunday School [coaching class].*
>
> *Teacher: Oh we can't say that (female, primary teacher).* [018]

In conversation, several teachers emphasised the importance of participation through personal rather than virtual connectedness, exemplified in this typical comment by a principal:

> *So I mean obviously there is still that need, I think, that real need for the social aspect of what we do, the face-to-face connection with kids. A lot of what's wrong with our society is because kids don't feel connected, and the school actually has a huge role to play in providing a connected kind of group that they feel safe in, that they feel that they belong to (female, primary principal).* [023]

However a shift in discourse was noted among teachers using the video-conferencing technology: they began to see this as a face-to-face method of communication because it was both visual and synchronous.

Situated learning with technology

Teachers in this study attempted situated learning in various ways, from deep to superficial. The activities observed and discussed all took place on the school sites. One example of situated learning was based on the model of cognitive apprenticeship, where students interact with professionals (Brown & Campione, 1994; Haslam, 2002). Two schools in this study were engaged in such a relationship with experts who, while they

played a role in mediating learning, did not usurp the teacher's role. Communication between novices (students) and experts took place through email and video conference. In one case the students were involved in design and production of web sites for external clients, a task that addresses the concerns of Scardamalia and Bereiter (1996b). One teacher described how a student grew from a legitimate peripheral participant (Lave & Wenger, 1994) into the role of expert, able to develop other learners:

> *He was completely removed from a teacher classroom situation and put into a real world situation. I think that is what really struck with him, that he was very mature and could connect with older people. And we realised much later on in the piece. Once we put him with that person from Rotary they just hit it off and they were emailing each other and he would come back all excited: "I've just learnt how to do this and let me show you how to do that" It just kept getting bigger and bigger so his confidence went through the roof. It spilled into the classroom as well because he became a mentor for the other kids and it wasn't just me as the teacher anymore. He would teach other kids and so before you knew it we had five or six kids that were the experts in that particular area (female, primary teacher).* [022]

Another saw an authentic, scaffolding purpose in students' spontaneous email communications:

> *Today they've done some work in the last five minutes on the email. Which is the funniest thing, because guess who they email? Each other. In the same room, there are five of them all emailing each other, but it's gossip stuff about who is asking who out. That's cool, got to have it and you're using modern technology so if, my intention is to have a school in another state next term, they'll be good at email (female, secondary teacher).* [008]

The implications of social practice include social critique (Cochran-Smith & Lytle, 2001), but this was rarely seen in the classes observed. However, one secondary teacher felt that teachers and students should discuss broader uses of communication technologies in society:

> *I think we need to talk about why we use the Internet. What does it mean? How can we use the Internet and for what purpose do we use it? You know we need to start talking to kids about the alternative Internet. How groups like environmental groups, the*

> *people that organise S11 [anti-globalisation protests], how they use the Internet powerfully as a sub media (female, secondary teacher).* [025]

6.6 Teachers focus on knowledge-building activities

Although the choice of learning tasks is a designing role, the way teachers mediate learning can affect how students develop their understanding of organising and searching for information; editing, redrafting and formatting text for various audiences; building microworlds and simulations, and creating models which they construct from a variety of sources expressing different points of view (Loveless et al., 2001). As indicated in Chapter 2, knowledge-building activities are those that allow students to become authors and creators of knowledge, a role that Renshaw (2002) suggests they need to learn. In the community of practice both students and teachers can work on this role if they have a conception of knowledge as a resource available to all.

Creating a pool of knowledge

In several cases in this study, teachers encouraged students to share their developing knowledge to build up a knowledge resource for the classroom community, as this teacher suggested:

> *There is an expectation in this classroom that no knowledge is sacred, everyone shares and if someone moves from one group they'll wander around the classroom and pick up an idea… Kids will come along and say, "Well why aren't we doing this? Why aren't we trying it that way?". So we have a go and if it works it's to our pool of knowledge and if it doesn't, we scrap it (male, primary teacher).* [004]

On another occasion he described in his journal how students connected with an expert outside the community to develop their knowledge pool:

> *One group has spent several weeks exploring how they could use graphs in Microworlds Pro. This involved looking at a project that plotted the height of a balloon on a graph and studying the Logo language script that had been used. The students also emailed the author and asked for some direction. They found out that they could open Excel Spreadsheets and from there they*

> *were able to begin manipulating data in Excel from their projects (male, primary teacher).* [004]

This group engaged in constructionism — learning through making things — (Papert, 1991) as they found out about the moon, created a lunar landscape in the school sandpit, wrote a script and then re-enacted the moon landing in 1969. One of the students, when playing with the settings of the camera, found a sepia effect to emulate early footage film. These two-minute movies were then imported into the Microworlds projects. The teacher described how he encouraged students to get inside the programs in order to create and construct:

> *In the middle school we start looking at programs like Excel, Microworlds Pro, Legodacta, HTML, firstly as just basic programs where the kids can use the software but as they move on into the senior primary they are using the language behind it. They're investigating how the thing works as well as using the program to express themselves in their assignments and classroom work (male, primary teacher).* [004]

In another use of video as a tool, a teacher arranged for the students to record action in science experiments and in the next session to share their reflections in a whole class discussion. This activity was observed, and it was clear that students were purposeful in their setting up and recording of the volcano experiment. Later the teacher reflected on the discourse prompted by this visual stimulus and wrote:

> *The reaction of the students watching themselves, and the talk on and off the video was interesting. Scientific concepts and language developed over the length of the video. This is the first time I had used the video camera in the classroom. I was impressed and certainly will use it again (female, secondary teacher).* [009]

In many of the classrooms observed, (re)production activities were common, as many students reworked material to produce a visual presentation, usually based on PowerPoint software, as a final product of their learning. However, often these productions failed to consider the audience, and were difficult to read due to design, colour or timing. The purpose of the presentation was sometimes unclear, giving students little guidance in design choices, especially where teachers were not familiar

with the software. With experience and feedback the quality of presentations increased. On other occasions, teachers and students continued to engage in consumption activities that may or may not have been parts of a holistic project. For example in some cases Internet searching was the entry point for a new topic, and led to the creation of knowledge products, while in other cases it appeared to be a disconnected, isolated activity.

6.7 Teachers scaffold student learning individually and collectively

Scaffolding learning implies that there is a distance between what exists and what one is capable of: in Vygotsky's terms, the zone of proximal development (ZPD). Teachers work with students to set expectations of capability, creating the ZPD, and then work together to meet those expectations. This presents a challenge for teachers in terms of knowing their individual students, leading Mercer and Fisher (1998) to prefer the notion of a community of inquiry, whereby cooperative learning groups encourage generative learning among individuals.

Scaffolding individuals' learning

Those teachers in this study who knew their students well were able to provide individualised scaffolding to varying levels, as required. One primary teacher described how he took the lead from students who knew their learning needs:

> *A lot of them know the areas they need to develop. They know the areas they want to learn more in. Not just need to — want to — so it's giving them that freedom to give you direction on where they want the guidance, where they want the help and what areas they want to attack themselves (male, primary teacher).* [005]

While explaining her view of scaffolding, his colleague revealed her feeling of inadequacy in scaffolding with technology:

> *It's actually creating opportunities for that teaching moment. You happen to be standing right near them, or someone's standing near them, so you see where something could go. It's being able to see where that next step is, and I feel I've got it in reading and in maths but I don't feel I've got it with technology (female, primary teacher).* [010]

Through scaffolding, teachers built student confidence to take risks, thus enhancing the dimension of imagination (Wenger, 1998) as this one suggested:

> *I think just little things like encouraging them to take risks: "Don't worry about getting things wrong. Have a go, don't be afraid" (male, primary teacher).* [005]

They also provided a range of ways for students to express themselves, often using technology, as this teacher explained:

> *So animating the sequences is a way that some boys are able to say, "This is what's going on inside my head". They can put it down, take concepts that are inside of their brain and get it down onto the computer. I guess as with the old tape recordings they can record their voice rather than having to write it each time (male, primary teacher).* [004]

Providing structures and supports

Many teachers referred to scaffolding as providing structures that they gradually removed, as this secondary teacher described:

> *Well, what I try to do is say over the course of a year or semester, I try to organise what I present to them, so it's less teacher structured. I gradually pull away the supports. Now, I must admit, I don't actually articulate that to the students (female, secondary teacher).* [007]

Particularly in the primary schools, teachers used a range of scaffolding tools promoted within recent years, as this one described:

> *Lots of graphic organisers, lots of metacognitive prompts... that was one that we worked on with the kids last year, if you need a helping hand here are some tips that we have come up with, we have built this one together. Things like getting to know your favourite search engine, so that you can always go to Yahoo if that's your favourite one, because you know it's a key word or a Boolean search or whatever. You know what's in the data bases and how to make the links (female, primary teacher).* [013]

She also described how she scaffolded Internet searching in a way that indicated she was experienced in the task herself.

> *I spend a lot of time with the kids just talking about, "Okay, well when you hit a new site, how do you read it? Do you look at all*

> *the pictures first, do you scan down to see if there's any video clips and click on those things? Do you look for a photo gallery first, or do you read from the top to the bottom and click on the hyperlinks as you come. Do you get lost? Do you keep clicking and clicking and lose your way and forget where you were at the start? How do you read it?" And therefore, getting kids to realise that there is a number of ways you can read a web page and therefore what's a good way, what are some good strategies to make sure you maximise your time or get the information that you want in a quick way? (female, primary teacher).* [013]

Her final focus on time and efficiency was echoed throughout the study. Another teacher described how he encouraged students to take shortcuts when word processing:

> *I typed out a sheet with different shortcuts upon it to be stuck on the table next to each computer. This sheet also contained basic logo commands for the children and teachers to use (male, primary teacher).* [027]

One reflected that he and other teachers had not provided enough support in a presentation activity:

> *It's something I didn't even think about I must confess. The kids got up there, they were flying by the…*[pause] *and I felt a bit sorry for them, I thought we could have given them a lot more help (male, primary teacher).* [031]

However the difficulty in achieving the right balance between open-endedness and structure concerned some teachers, like these two:

> *It means we have to structure some of it. If it's open ended, some students will just not get there and if it has that element of structure, for some kids, it provides a bit of a security blanket and a safeguard that they can use (male, primary teacher).* [004]

> *There was a number of kids who did very little because it wasn't so structured. They just floundered in that crack (female, secondary teacher).* [009]

Timely interventions

Mercer and Fisher (1998) suggest that the timing of mediation is important. In many observations, teachers noticed material on computer screens and initiated scaffolding interventions with individual students. In one secondary classroom, the technically-

skilled teacher in Figure 6.3 took on an expert role and coached one student without dialogue, taking the computer mouse.

Figure 6.3 Scaffolding intervention (school E)

The interaction unfolded as follows:

> *See here where it's got Auto: this is for people who are probably pretty expert so we'll go into this one, Auto. I'll set it up for you, which will make it a lot easier. You know in Publisher where they have an automatic wizard, it's like that. Now what you've got up here — generic — means for any sort of presentation. OK, Now you're doing it on screen, and that's where you type in [topic]. So off you go. Type in [topic] there.* [007]

The student typed in the title using one finger of his left hand and the teacher continued with the technical instructions:

> *You can change the fonts and everything later. Just set it up at the moment, and see if there's anything you don't like about it, OK? (female, secondary teacher).* [007]

In this case the task — presenting a report on a disaster — appeared to be paramount for both the teacher and student, and the computer program was just a container for the knowledge. The teacher in this case instructed the student regarding the program. Hence little time was spent on interaction regarding the mechanics of the program, in order to focus on the content. One conclusion that can be drawn from these observations is that where there is proximity between teacher and student mediation can occur in a timely manner even if the interactions themselves are brief.

New forms of structure and support through computers (Stahl, 1999) included using school Intranets to store useful prompts, and private email dialogue between teachers and students. In some cases teachers scaffolded learning by providing electronic exemplars of the products they expected, developed and demonstrated themselves or by other students. This type of scaffolding was rarely observed, but a teacher writing in her journal noted one instance:

> *[Two teachers] decided to show the Grade 5s a finished history timeline from last year. This was done today and they said it was a worthwhile thing to do (female primary teacher).* [026]

Another primary teacher was observed reminding the class about past examples of student work at the beginning of a collaborative project:

> *You might want to put things like biographies about individuals. You might want to set up a re-enactment. Remember last year how Jack's team put together an aboriginal dance and whatnot? (male, primary teacher).* [004]

In yet another school a teacher reflected on providing such exemplars, particularly drawing on her preference for visual cues:

> *They've got to have a picture of something else, don' t they, before they can think "Well I'd like to learn that". You sort of have to see it. You need to have some idea of what it might look like at the other end (female, primary teacher).* [010]

Expectations

While research indicates that teaching quality is enhanced where teachers set high expectations (Russell, 2000), some teachers had difficulty clarifying appropriate expectations in terms of using computers. One teacher commented:

> *I'd like to have a better picture in my head of what would be a good place to take them to next, to guide them. In terms of addressing them, it's just finding what each child is interested in and what sparks their imagination and excitement and just heading in that direction (female, primary teacher).* [010]

There is evidence that students can set their own high expectations, as in this case where two schools worked together, making their work more public and exposing their own skills of teaching. One of their teachers reported:

> *The students have indicated that aside from the obvious benefits there is an element of pride to ensure that the work that is being produced is of a good quality because you are working with people you do not know well.*
>
> *They all felt that it is easier to do project work within the school compared to OCM [Online Collaborative Mentoring]. However they all felt that more is learnt from an OCM project because it is more difficult, as you have to have to know what you are doing and be able to instruct someone else as you work with them, which is more rewarding (male, primary teacher).* [004]

In the socio-cultural view, as technology is developed by people it acts upon our environment, thereby altering the course of human development. One teacher captured this aspect, underlining the need for teachers to let go and allow their students to fly:

> *The technology is so open ended, it affords your bottom-end kids scope to produce something great but your high fliers can just go to places that you never even thought of (female, primary teacher).* [013]

6.8 Teachers and learners talk together to increase learning

Talk plays a major part in scaffolding learning, and the introduction of computers has led some to suggest that the computer can take this role, or can mediate the teacher-student or peer-peer dialogue. Leask and Pachler (2001) argue that learning with computers is more likely to occur through interactions between teachers and students (rather than students and machines) whether they be in the form of dialogue, reciprocal teaching strategies (Palincsar, 1986), Socratic questioning (Burbules, 1993) or conversation (Cherednichenko et al., 2001; Laurillard, 2002). This involves social competence for both teachers and students in learning to listen and negotiate, engaging in exploratory talk and expressing tentativeness, courage to express ideas, persistence in problem-solving and generosity to acknowledge the good ideas of others (Renshaw, 2002).

Dialogue and conversation

Teachers in this study were rarely seen at the front of the class, and rarely talking to the whole group at once, except for initial instructions at the beginning of a session (mainly

in secondary classes) and whole-group reflection at the end of a primary class. They frequently engaged in face-to face dialogue and conversation with small groups or individual students, treating the computer as a container for artefacts that were the focus of discussion. Numerous interactions took place in front of computer screens as teachers moved around classrooms, stopping to talk with students.

In one observation in a primary classroom, a student and teacher engaged in a learning conversation (Laurillard, 2002) regarding task content, while at the same time a peer mentor provided advice on technical needs, with which the teacher did not engage. The task, chosen by the teacher [018], was to create a PowerPoint presentation on a topic related to human relations, which she had discussed broadly with the class, and the student had created a file entitled *What makes a baby to be born*? Seeing this on the screen as she came to talk with the student, the teacher asked him to explain the meaning of this title, which he did. She suggested that the title could be modified and shortened to make the meaning clearer, after which the student suggested *Birth* as a title, and the teacher agreed. He then turned to his peer mentor for a different type of conversation, asking her how to change the words in the computer program, which she explained. As he made the changes, he modified his conception of the title, reinstating his conversation with the teacher by suggesting *Birth and Pregnancy*, to which she once again gave feedback, saying "What about *Pregnancy and Birth*?" as this made chronological sense. He again modified his action, and the teacher continued the conversation by asking if he had any sound in the presentation, donning the headphones and listening to the opening drum roll and gunshot. In this dialogue, while the teacher and student negotiated their views of the subject that was displayed on the computer screen, the teacher took an active role in modifying the learner's perceptions.

In another example, the focus of the conversation at the computer in a secondary classroom was also content. A male student initiated the dialogue by asking the teacher a question about krill as part of his research on Antarctica. The teacher read the material that he had copied from the Internet on screen with him until the student said, *"Now I know what that means."* The teacher then asked *"Do you need to put it in your own words? Do you know what the four levels of species are?"* As they read the slide

together, the teacher suggested *"Maybe you don't need that in there, get rid of the primary producer. So we're going from the basic photosynthetic…"* [008]

Communication tools

Electronic dialogue and asynchronous communication such as email can support knowledge building, allowing students to take time formulating a contribution, and reducing the barriers which prevent some from taking part in oral discussion (Scardamalia & Bereiter, 1999). Furthermore, a record can also be kept for reflection. Group communication through distribution lists and online chat can lead to further sharing. Teachers and students in this study used email both as a private, asynchronous means of communication at various points in negotiating and completing tasks, and for social communication. The private discourse that took place in one primary classroom followed students establishing research questions, emailing their proposal and negotiating via email with the teacher. In another even stronger scenario, a primary student suggested that all students email their research results to the whole class, with a final production on each student's home page. Their teacher explained how this came about:

> *Email was a really big thing with my children. Emailing each other, emailing them at home, and they'd email me all the time. I had them sending their work to me (female, primary teacher).* [018]

There were several examples of students keeping in touch with their class while travelling overseas, as this teacher described:

> *And also he would email the children and they would just email each other just to find out "What is he doing and how is that different to life in Australia?". So there is all that sort of thing and we take a lot of that stuff for granted, because it's second nature to them (female, primary teacher).* [021]

But mobile phones were not encouraged among students, except in one secondary school where they were allowed for social connectedness. Primary teachers did not mention them at all, while one secondary teacher explained:

> *Mobile phones we ban because their use isn't necessarily appropriate, even though some mobile phones now you can*

connect to the Internet. But it also brings up billing and other socio-economic issues (male, secondary teacher). [001]

It appears that at present, management concerns override potential mediation of learning in the case of the mobile phone.

Questioning

Many teachers were observed using open-ended questioning techniques to encourage students to think about problems as they arose, whether they were to do with understanding computer programs, malfunctioning equipment or higher order thinking. These interactions are affected by the physical layout, especially in the pod arrangement if the students using computers are distant from the teacher's gaze. One primary teacher described her process of dialogue:

> *A lot of questioning, it's not statement orientated. You're questioning the children so you pose a question and you're getting them to give you an answer to that. Open-ended questions and open-ended thoughts. Just getting them to think beyond that whole (female, primary teacher).* [021]

However a secondary teacher lamented:

> *If students have a question, I don't always answer it. I say, "Why don't you go away and investigate and see if you can find the answer?". Quite a lot of students say, "I won't do it any more if you won't tell me" (female, secondary teacher).* [007]

Story-telling

A secondary teacher reflected on another form of dialogue initiated by story telling, and hinted at the sense of imagination noted by Wenger (1998):

> *When I did Dip Ed, one of the things that was drummed into us was that the kids like to hear stories. That's just really interesting, you can just see it, they tune right in, but they don't tune into your directions, that's the thing. When a story comes along they really tune right into it. You certainly do notice that, and that's one of the good things about it. And the thing is too, the talking, introducing the Nazi period, the kids went right off on a tangent, to the Holocaust and that was one of the good things coming out of that class. It's really good that they're interested*

and want to know about those things. You don't get that very often in teaching (male, secondary teacher). [016]

This form of talk was rarely seen, as whole-class discussions were also rare.

Discussion

In terms of mediating student learning, the findings of this chapter indicate that it is likely that in order to build knowledge:

- teachers help students learn how to learn
- teachers share teaching and learning with students
- teachers and students monitor and assess learning together
- teachers build on students' prior experience
- teachers facilitate connections between people
- teachers focus on knowledge-building activities
- teachers scaffold student learning individually and collectively
- teachers and learners talk together to increase learning.

Many classrooms operate as communities of learners in which teachers are important as experts in the processes by which knowledge is created, rather than as the source of all knowledge. In reality they are both expert and novice, confident that they can articulate processes and goals, model teaching and learning and work as partners with students, but aware of their lack of expertise in technical skills and in practical applications of computers. Hence the first findings (6.1, 6.2, 6.3) are focused on expertise and power relations in the classroom culture. Many teachers defined their role as experienced lead learner in the classroom community. This represents a shift in power relations and is one of the important effects of technology on the role of the teacher, as it raises awareness that change is possible, possibly by creating the conditions for change rather than the change itself. Although teachers expressed their knowledge of teaching and learning privately, primary teachers tended to discuss teaching and learning with their students more than secondary teachers, and incorporated action and reflection into their classroom practice. Many teachers in this study saw learning how to learn as an aspect of students becoming more autonomous learners.

In conjunction with the first proposition which is essentially a stance, the second and third refer to processes whereby teachers share teaching-and-learning with students. Although not all the teachers in this study were comfortable with their sometime novice

status, they were generally able to reveal this to students without feeling they were losing face. While teachers and students do not (and, one might argue, should not) have equal responsibility for this in the classroom, a small number of teachers appeared to have relinquished any claim to expertise with regard to technology, displaying marginality (moving out of the community) rather than peripherality (becoming more central) (Wenger, 1998), which is of concern in terms of their continuing role both as teachers and learners. In the social constructivist classroom, collaboration among learners is important, but since students are *apprentices* (not yet experts) in the processes of learning, it remains the teachers' responsibility to be a meta-mediator. In this study the amount of time teachers spent on this was small in comparison to the time spent on managing people and resources, particularly in the short sessions (less than an hour) typical of secondary schools.

Mediation builds on learners' prior experience, and the findings show that teachers generally recognised the value of building on students' prior experience and all the diversity of culture, language, gender, ability and resources they bring to the classroom. To work within individual zones of proximal development, it is important that they know their students well, and teachers in this study generally addressed this through informal means such as observation and conversation. While some teachers appeared to know their students well, others, especially those with fragmented contact, found it quite difficult, and in some cases resorted to addressing collective zones of proximal development. No teachers mentioned using tools such as surveys or portfolios to identify prior experience. The boundaries between home and school and between primary and secondary experience were not often crossed, although a few teachers raised this as a concern. To a certain extent, other connections were made linking the classroom to a broader community, as teachers attempted to situate learning in society. At one extreme were the activities in which students worked on projects for external clients, while at the other were very limited attempts to add authenticity to tasks. Social critique, whereby teachers mediate students' local experience of technology through reflection on other perspectives in a wider context, was not evident in classrooms.

Teachers generally valued physical interaction above online interaction, although there were signs that for some, *face-to-face* now includes communication through video conferencing. Most teachers saw electronic communication as an adjunct to, rather than a replacement for personal contact. They interacted personally with students using computers in much the same way as they did with students using paper and pen, referring to the text or image in front of them, asking where information had come from or why it had been chosen, for example.

Teachers in this study were testing out their approaches to scaffolding, attempting to find appropriate balances between openness and structure, and trying new ways of computer support for student learning both individually and collectively. The teacher's skill in structuring learning situations and knowing when to remove the scaffolds depends to a large extent on his or her knowledge of individuals, and of a range of scaffolding tools and strategies, including knowing how and when computers can assist. Together, teachers used a range of strategies, including graphic organisers, structured Intranets and talk with students, although individually they tended to specialise.

Activities likely to create knowledge (as described in Chapter 2) were less frequent than (re)production and consumption activities among the teachers and students in this study. While there are times when it is appropriate for teachers to mediate learning through direct instruction and consumption of digital information, the issue is one of increasing repertoire, so that consumption does not dominate. Similarly (re)production activities have their place, but they can be taken further into knowledge creation when they are used to build up the pool of knowledge in the classroom, the school and society. Working with peers and experts in other settings, both international and local, appears inevitable. Therefore if teachers are to reach the potential for mediating student learning, it seems that they need to know what is possible with computers and how to ensure that their students can learn the necessary program skills when required.

This chapter has presented findings regarding teachers' role in mediating student learning, which, in conjunction with designing the learning environment (Chapter 4) and

managing people and resources (Chapter 5), forms a triad of classroom roles revealed by this study. In the next chapter, another important classroom role which influences all three — improving practice — will be discussed.

Chapter 7 : Teachers improve practice

The three previous chapters have presented findings in relation to three roles of teachers: designing the learning environment, managing people and resources and mediating student learning. As was described in the conceptual model in Chapter 2, and repeated as Figure 7.1 below, these provide the substance of the fourth role of teachers: improving practice. This final chapter of findings from the study presents data regarding teachers' role in improving their practice, based on an understanding that teachers in their workplaces are constantly learning and contributing to improvement.

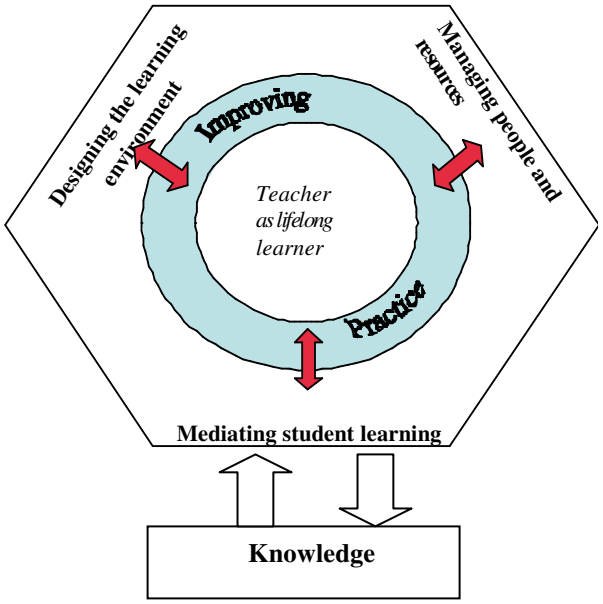


Figure 7.1 Model of teachers' roles

In this role we see how teachers act on the society of the classroom and the school to effect change, while themselves modelling lifelong learning. In a broad sense, the purpose of teacher learning is to improve practice, and the literature in Chapter 2 considered a social constructivist approach to teacher learning, which implies that teachers value and build on each other's prior experience and their multiple perspectives when talking about their practice (Baker et al., 2002) and conducting collaborative inquiries (Ball & Cohen, 1999). If teacher professional development is to be

experiential, grounded in inquiry, reflection and experimentation, collaborative, sustained and ongoing, and connected to their work, as Darling-Hammond and McLaughlin (1996) argue, it is likely to commence in the workplace. Professional learning is therefore not separated from professional practice: rather, professional learning emanates from and is part of professional practice.

The findings of the previous chapters have developed the concept of a community of practice based in the classroom, as teachers and students work together on the task of constructing knowledge. In this chapter the concept is broadened, so that a knowledge-building school is seen as a constellation of such communities (Wenger, 1998), where all teachers learn and deepen their understanding through the practice of constructing professional knowledge. Within a school there are expert and novice teachers as well as expert and novice students, and to become full participants teachers and students must engage with the technologies of everyday practice and connect with their history, as well as participating in the social relations, production processes and other activities of the community (Lave & Wenger, 1994). In this way they move from the periphery to the centre of the community. Cochran-Smith and Lytle (2001) suggest that teachers' inquiry should also have a social purpose, connecting local knowledge to larger social, cultural and political issues. In a culture of teaching-and-learning, teachers (and their students) can contribute to shaping the new roles of the teacher, the organisation of schooling and the future of the profession. These could prove to be major tasks with profound impacts on society.

In the three previous chapters the detailed areas of teachers' classroom practice that provide the content for teacher inquiry —designing, managing and mediating —were described. In this chapter ten propositions about how knowledge-building teachers improve their practice within their workplace have been developed from the data in light of the literature. Because the context of the study is classrooms using computers, many of the examples refer to computers, and as with the other chapters, the extent to which individual teachers display the characteristics differs. The teachers continue to be identified by gender, school type and identification number.

7.1 Teachers encourage each other in new ways of working and learning

If the qualities of flexibility, networking and creativity are important for students, they are also important for teachers, according to Hargreaves (1999). In the context of classrooms using computers, teachers need to be flexible and opportunistic to develop new ways of working, and this can be enhanced or thwarted by school culture and leadership (Hord, 1997; O'Rourke, 2002). Where principals and teachers look out for each other, it seems they are able to take on new ways.

New ideas or new teachers?

Since knowledge building requires new ideas and connections between ideas to be made, it seems that in knowledge-building schools teachers will be open to, and excited by, new ideas, and supported by school leaders. Several participants in this study spoke of long-term and broad-scale changes in the arrangements for schooling, and some, particularly principals, encouraged their school communities to develop a vision for the future. One principal suggested:

> *I guess it does come from the leaders within the school. Obviously you have to have people who have vision and who can be lateral and look beyond what's going on in the day to day grind (female, primary principal).* [023]

Similarly, a teacher commented

> *If we had a principal who came in who had knowledge of learning technologies, and had the ideas and the vision of down the track and the way to achieve these things, then we'd be a lot better off (female, secondary teacher).* [008]

A principal in another school did express some thoughts on future schooling:

> *I suppose it's far off down the track, but we might be able to teach children from home. There are projects that different people have got underway. You do it online… but more than that, it might be that we've got people coming in for different times of the day, and then learning at home (female, primary principal).* [024]

In order to sell ideas like these, principals considered teachers' individual differences, just as teachers use their knowledge of individual students to help address learning needs, as this principal reflected:

> *Well everybody copes differently, I guess, and some people take longer than others to put their foot in the water. It's the age-old adage that you go with the goers (female, primary principal).* [023]

Other participants referred to teacher attitudes to new ideas, indirectly raising the issues of the ageing teaching service and the effect of personality on openness to learning and hinted at the potential for workplace learning to maintain the status quo. One experienced teacher raised concerns about age, or more specifically, lack of other experience:

> *I think as well the teaching age group has a bit to do with it. People get stuck, they've been in the school for twenty years, twenty-five years or whatever, and they tend to think this is the only way to do it (male, secondary teacher).* [016]

In another school a relatively young teacher also expressed the need for exposure to new ideas:

> *I guess all the research in the end says the difference between classrooms is the teacher. But if the teacher is not exposed to different ways of thinking, new ideas and new understanding they'd probably continue along the track that they've always gone on (male, primary teacher).* [004]

Intrinsic motivation for learning was apparent among many of the teachers. A lively middle-aged teacher of fourteen years' experience expressed the flexibility required of teachers and gave a reminder that personality can be more influential than age or years of experience:

> *I've always been on the go. I remember at Dip Ed [postgraduate Diploma] going through what sort of teacher you're going to be and "what did you see in your rounds?". We came up with about twenty-eight different sorts and I've always kept them in my mind. I like the idea of twenty-eight different sorts (female, secondary teacher).* [008]

Similarly, in the spirit of the learning community, another very experienced teacher credited technology with her revitalised approach to teaching, interestingly *because* there was so much for her to learn:

> *Before technology I used to really get bored with teaching and I used to think: not the same old thing. How can I change it? How can I make it different? How can I make learning more engaging, how can I made teaching more engaging, so that I'm not bored? And with the technology, I can't get bored now, because there's so much I don't know (female, primary teacher).* [013]

In spite of a conversation prompt, few teachers raised the issue of new roles for teachers. One principal suggested:

> *Well their role is to me as a facilitator and it's to get the kids engaged. So I don't think technology is going to change our role in terms of that responsibility, but it will be a different kind of role, much more of a counselling, nurturing kind of role (female, primary principal).* [023]

In contrast, a teacher who believed that teaching was changing saw a need to discuss this with other teachers, to address any fears:

> *We haven't really discussed as a group about how our own work has changed, how our role has changed and the fears that might come from that (female, secondary teacher).* [025]

Sources of inspiration and innovation

There are numerous ways that new ideas can be found, from professional reading and visiting other schools, to working with challenging experts. A great deal of research reports on the importance of the school leader in promoting new ways of working (Hord, 1997; Leithwood et al., 1999). One teacher explained how strong leadership influenced major cultural changes:

> *Leadership initially. Then it became a grassroots movement. It was an example to me of how a transformational principal could actually force that change (female, secondary teacher).* [025]

Within an ongoing professional development relationship with two other schools, a primary school worked with futurist educator and author Hedley Beare to consider future scenarios, as the principal explained:

> *Hedley [Beare] really put where we're at in context with the staff in terms of talking about reality. This is way the world is going to be in the next five, ten, fifteen years (female, primary principal).* [023]

A teacher in the school reflected on the importance of the activity and the involvement of academics in supporting teachers through a change process:

> *For our staff it was a real confirmation of yes, this is what we're doing, and we're challenging those limits. Just to give them that positive reinforcement because it was a huge shift… to let go and move in to that different realm of teaching and learning. These children are going into a very different world and are we equipping them for what's ahead of them? (female, primary teacher).* [021]

The Internet has potential as a source of new ideas, although teachers more frequently used it as a curriculum resource than to gather ideas on other aspects of professional practice. Teachers are also exposed to new ideas through visiting other schools and crossing into other communities of practice, and this occurred infrequently among teachers in this study, although all had funds for professional development through the Successful Integration of Learning Technologies (SILT) Project. One participant used the funding to pay for relief teachers, and reported on the outcome:

> *I visited [another school] for two days. That was very beneficial. I got all inspired and came back and set up the SOSE Internet page (male, secondary teacher).* [016]

Teachers clearly espoused the notion that they are learners, and claimed that they learn from students and other teachers, but some did not see themselves as responsible for developing others in a symbiotic relationship. One teacher expressed his view:

> *I think you have to look as yourself the same way you look at the kids. Trying to become an independent learner, so you have to develop yourself (male primary teacher).* [006]

This individualism is not surprising, given the culture of schools and system requirements for career progression. However a knowledge-building approach would suggest that teachers should move from independence to interdependence, from developing themselves alone to developing and being developed by, others (Jones et al., 1995; Venezky & Davis, 2001). One principal commented on this occurring in her school:

> *They bring people along and there's a lot of teamwork. To make this kind of stuff work you can't be a little island in your classroom with your door shut like we used to be (female, primary principal).* [023]

7.2 Teachers frame personal and social goals for their learning

Setting goals for professional learning clarifies purpose, and just as students are motivated by ownership of their learning, so too are teachers (Beattie, 1995). They should be involved in framing the goals and means of their professional development (Clark, 2001), linking them to school and societal goals (Cochran-Smith & Lytle, 2001). Currently system-wide and school-based performance management protocols in Victoria require teachers to be involved in individual goal setting (Department of Education Employment and Training, 2001), but do not specifically require group goals or broader purposes for teacher learning.

School goals inform individual goals

Principals are concerned with setting school-wide goals that form the context for teachers' personal goals. Two primary school principals worked in collaboration using the whole-school design elements, including professional development (Hill & Crévola, 1997), to look at school-wide goal setting. One stated:

> *We've been taking the Hill-Crévola model and looking at it from a leadership perspective. "Here's the target. How do we use these nine elements? What do we have to do with each element to support that to happen?" We're a long way down the track (male, primary principal).* [032]

Teachers and principals commonly spoke of documenting individual professional development linked to school charter goals and priorities, as did this principal:

> *We have a PD [professional development] sheet, the charter priorities. Everyone must do a PD associated with the priorities, and then there are projects like IBM and SILT, and a personal part where people choose to do things for themselves. And we document that and keep a record (female, primary principal).* [024]

The Department of Education and Training provides a framework for performance management and professional development, implemented and adapted to individual school requirements. However, for some, this is a relatively new experience and the emphasis tends to be on proof of activity rather than purposefully building a pool of knowledge. One teacher referred to the process:

> *The teachers need to set goals for themselves each year and work towards meeting those. I think the new agreement tries with the PD [professional development] plan. I think we're trying to get to that point (female, secondary teacher).* [025]

In another school individual plans were the norm for all, but there were indications that team goals were also important, as this teacher described:

> *They set their goals, they set their objectives and they work to them. So individual learning plans happen for teachers, students and administrators. It's a lot of extra work at the moment but once it's in place it should be something that enriches teaching in a really powerful way. I think participants need to set learning and teaching goals for the project so that they can evaluate personal as well as team success (male, primary teacher).* [004]

There was however little evidence of a recursive, reflective approach to setting teachers' learning goals. Only one principal (and no teachers) referred in very general terms to the annual review of goals within the performance management system:

> *We also get the staff to go back and evaluate [goals] at the end of year to see what they have actually done, or if they have changed through the year (female, primary principal).* [024]

A sense of purpose motivates teachers

Teachers' learning includes an awareness of their beliefs about technology capability and some knowledge of its underlying conceptual framework (Loveless et al., 2001). This knowledge helps in setting and achieving goals. Like students, teachers benefit from learning when the need arises, using the resources at hand (Jamieson et al., 2000),

and most teachers articulated a need for just-in-time learning to match their personal purposes. This purposeful learning does not necessarily fit well with system-level professional development programs. These two secondary teachers were typical in their comments:

> *I usually find that I learn a lot better if I have a precise application for it in the very near future. I find that you look through PDs [professional development activities] that are offered in learning technology, and you think that would be interesting and you go there. You spend the whole day doing it. Unless you go home and actually use it the next day in your own classroom, I find that you tend to forget what you are doing. So it's only by constantly using it that you improve your skills, at least that's how I find that I learn (female, secondary teacher).* [008]

> *I haven't done web publishing because I don't know what it actually does. Do you know what I mean? Just giving me a name, I don't know how it's going to apply to me. So I'm not interested in doing a web page, unless I have been told beforehand what are the possibilities in my science classroom (female, secondary teacher).* [009]

Because of this need for purpose, not all workplace professional development is seen to be useful, especially if it is top-down (Hargreaves & Fullan, 1996) or outside-in (Hoban, 1997), presenting a product before the participants have established a purpose in their own minds. While teachers in this study were familiar with setting goals on an individual basis, the relationship between these goals and appropriate opportunities for professional development was in some cases rather tenuous. Many teachers referred to school-based technology-training activities offered with good intentions in a smorgasbord manner, like this one:

> *We have been offering PD [professional development] for five years after school and this first semester everybody had to do a couple of minutes on different things (female, secondary teacher).* [008]

In one secondary school a purpose was clear, at least in the mind of the SOSE coordinator, who said:

> *We're incorporating FrontPage, web pages, and PowerPoint into teaching. What we're offering over the next month is each teacher in the SOSE KLA to come along to practical hands-on*

> *sessions in those software applications so they can incorporate that into their actual assignments (male, secondary teacher).* [016]

However in reflecting on his own professional development he displayed a common concern — application and practice must follow (Joyce and Showers, 1998) —and if access is difficult the skills will not be practised, nor implemented in the classroom. Speaking about his own professional development, he said:

> *I think it's important, but at the moment it's not as important as getting access to the computers. This year I've done a lot more on web page design and PowerPoint. I'm quite happy with all the things on my laptop that I know, but if I can't get access to the computer room, it's pointless (male, secondary teacher).* [016]

While goals were frequently documented, teachers other than the reflective journal writers did not appear to document their achievements or milestones along the way, and school cultures tended to focus on a summative review within the performance management process.

7.3 Teachers make time for sustained professional learning based in the workplace

If, as Day (1999) argues, time and opportunity are key factors, but scarce resources, in teacher development, new ways of looking for these are required. When learning is situated in the workplace, it is more likely to address substantive concerns as well, such as learning to integrate technology into the classroom to meet a current purpose. Although the teacher's workplace, the classroom, is a suitable place to start (Wenglinsky, 2000), a broader conception of the workplace (incorporating school and community, for example) is required to enhance knowledge building.

Lifelong learning

The need for ongoing professional learning was accepted by all in this study, and was an issue that principals were particularly concerned to address across their schools, as this one expressed:

> *I think the trouble with technology is it's a continuous never-ending thing. It's going to be year after year after year and I thing you're going to have to get used to that. The teachers have to keep going back and learning more all the time. How you do that is an issue (female, primary principal).* [024]

Two other principals focused on situated, lifelong learning opportunities for teachers, starting with the classroom but looking outward:

> *I believe if you want teachers to work with students and create lifelong learners then they need to be encouraged to be life long learners themselves. You've got to give them the opportunity to see beyond their own classroom and beyond the daily work grind, and give them the time (female, primary principal).* [023]

> *It has to be authentic, which is why it has to be placed in classrooms. It has to be on about what we're on about. It might be a refocusing about how a teacher evaluates and plans their daily classroom practice. Enhancing that, not adding to it (male, primary principal).* [032]

Teachers learn from each other

Sustained workplace learning includes modelling teaching practice for other teachers, one of the performance management criteria in Victoria (Department of Education Employment and Training, 2001). This was overtly part of the culture among teachers in some schools, as this teacher expressed.

> *There is a lot of talking and a lot of role modelling from the other staff as well. They are given the chance to see the other teachers in action (female, primary teacher).* [022]

However for another, it was a hope rather than a reality:

> *We shouldn't sit around and talk about what our staff need to do: we should be in [classrooms] working with them. Principals should be the best teachers and so should assistant principals, they should be essentially teachers and they should continue to model that to their staff (female, secondary teacher).* [025]

As part of the Navigator School program in the late 1990s, teachers were expected to open their classrooms to other teachers across primary and secondary schools, which had the effect of raising the accountability of teachers in these schools to a wider audience.

One principal spoke of the power of this experience in terms of professional learning for the teachers observed:

> *To me the power of what we experienced as a Navigator School was the fact that we a goldfish bowl, so we were accountable. We had to be able to articulate (male, primary principal).* [032]

It could be expected that this would also benefit the observers who cross classroom boundaries. For example, a teacher in another former Navigator School reported interest from secondary teachers in observing classrooms:

> *They [secondary teachers] have asked to come and work shadow us a bit, and that's happened (female, primary teacher).* [013]

Professional learning teams are a structural initiative used in some schools in Victoria to cross boundaries of professional practice within a school (Hill & Russell, 1999; Johnson & Scull, 1999), but they were not a feature of most schools in this study. Only two participants referred to this model:

> *We have done a lot of professional development about developing those professional learning teams, where you actually build on what you've already got (female, primary principal).* [023]

> *I think at Years 7 to 9 particularly there's no reason for the KLA [Key Learning Area] to function as a discrete entity. I think you need to remove the KLA and have a team, with a team curriculum plan and a team curriculum leader and teachers that are working together without the shelter of the cloak of the KLA. I think the main emphasis needs to be on student learning and thinking. How you develop tasks and how you think and how students learn rather than the KLA (female, secondary teacher).* [025]

However, particularly in the primary schools, there was frequently formal and informal collaboration between teachers in teams, although the term *professional learning team* was not used.

Finding time to learn

As Leonard (2002) found, even where teachers believed they should work together, their actual circumstances, particularly lack of time, make this difficult. Teachers in this study

frequently raised concerns about the amount of time available to them due to other professional demands, although they did not raise personal issues of work/life balance. One principal explained:

> *You've got to develop a shared vision with the staff and say, "This is our bucket of money, these are the things that we really want to look at doing and changing and being. Do we continue to spend the money on the same old kinds of budgets that we have always had in school or do we get a bit creative about it?" We say to staff "What is the most valuable thing for you?" And they will tell you "Time" (female, primary principal).* [023]

As schools increase in size it can be more difficult for teachers to find the time to collaborate (Leonard, 2002). One secondary teacher reflected this in his comment:

> *The key for teachers' take up is the time aspect. You know, if we haven't got time to take it up then quite often we are not going to do it. If you are not going to be able to practice something… The situation in a perfect world, the PD [professional development] budget would be a lot higher and we would have a lot more time to be able to get out and get practice. Gone are the days when staff had time to sit around and talk about these things, to professionally share. Size, too, we were 750; we've now gone up to 1250 (male, secondary teacher).* [001]

But in some cases teachers made time through scheduling lunchtime meetings or using planning time differently. In one primary school, teachers allocated time each week to meet for reflective writing:

> *It's voluntary. We're not doing that because we have to do it. We're doing it because we want to do it (male, primary teacher).* [030]

In another school, a teacher spoke of negotiating flexible scheduling to address teachers' need for time:

> *And so you say "If we make a commitment to you that you have x number of days that you can work out, negotiate with us to work on some of these really fantastic projects that you think about" because often people say "Oh we just can't get involved" or "It is just too much extra" (female, primary teacher).* [023]

However, even where the school can provide time and resources to release teachers from their classes, it often requires replacement teachers. A teacher raised this concern, and then suggested a partial solution:

> *But you have to understand as well that there's not too many CRTs [replacement teachers] floating around, so it's not so much money: it's people out there. And if there's three or four people sick and they can't get a CRT it puts a lot of pressure on. When the Year 11 and 12s finish it frees up some time (male, secondary teacher).* [016]

7.4 Teachers learn through play

Hargreaves (1999) suggests that teachers need time for tinkering and classroom experimentation: the teachers' equivalent of the open-ended learning so valued by the constructivist approach, because it allows people to be active and creative (Kane, 2000). Play is also a means by which they can explore, experiment and become familiar enough with technology to ask the important questions about its role in society (Selfe, 1999). Play can be just-in-time and purposeful, enjoyed alone or with others. Many teachers in this study reported learning in school or at home as they played with their laptop or personal computer. One principal who supported giving teachers opportunities to play with technology reflected a common concern about outside-in models (Hoban, 1997) involving development *put on* people:

> *The more the teachers have an opportunity to play with the equipment themselves, the more they discover, and the more they say " I really need to know about how to use the Internet properly because I am finding so much fantastic stuff". So then that's when they drive the professional development. I don't think it's effective if it's put on people (female, primary principal).* [023]

Teachers frequently described the processes of learning through play, and many were confident enough to introduce new applications of technology to their students after relatively short periods of exploration. One experienced teacher reflected on learning to use her laptop computer through mutual tinkering with other teachers:

> *As a whole staff we started off with our laptops at the beginning and only knowing how to turn them on. I would want to know*

> *how to use something, so I would play. I would ask somebody else and then I was happy. I would introduce it to the kids then, and reading the manual was absolutely the last resort (female, primary teacher).* [013]

An early career teacher described her appointment to a Navigator School, and how she learnt through exploration during her first year of teaching:

> *We did computers at Uni, but I never thought I would have a computer in my classroom, so it just went in one ear and out the other. So when I came into my classroom with five computers, I thought, "oh my God, what am I going to do?" And it was just a process of every day after school I would sit down and explore something new. I just started doing Microworlds and playing around. I would come up with some things and I would try it with the kids and I would just explore that way (female, primary teacher).* [012]

While structured learning packages incorporating video are often produced to support software, and some schools had purchased them to assist individual teacher skill development, only one teacher mentioned these, and she too preferred the benefits of open-ended exploration:

> *I have accessed the self-paced packages. The only thing is I probably find that a bit frustrating. They are great to start on but after that, I find them frustrating, because you are too bound by the format of them. I tend to want to break out of that, but I do find it a good starting point (female, secondary teacher).* [007]

Like other forms of situated learning, play requires time and access to resources, and it seems, a tinkering attitude. The laptop computers subsidised by the Department of Education and Training provided teachers with a purposeful plaything as well as a work tool. For some teachers, though, unstructured play is uncomfortable, and the need for a work-related purpose is paramount, particularly among women, as noted by Delaney and Dyson (1998). One female teacher expressed the need for a purpose for her own use of computers, rather than *just mucking around*:

> *I'm really enjoying my laptop. I'm doing my timetable, and my work program, all that, but I'm doing it religiously now. I was*

just mucking around last year. I can see the point (female, primary teacher). [018]

7.5 Teachers learn through dialogue and conversation

Teachers, like their students, learn through dialogue and conversation (Baker et al., 2002), and through this develop a shared discourse (Hogarty et al., 2002). Two discourses are well known: that of the local school community and that of the system. This gives rise to a concern that teachers have no personal professional discourse that crosses local boundaries, leading their discussion of practice to be subsumed into the system's narrowly-defined language (Cherednichenko et al., 2001).

Shared discourse

Some teachers recognised the discourse gulf, as this one noted between two schools:

> *During this project we have noticed that the dialogue changes because it becomes shared dialogue and as it becomes shared dialogue it's shared understanding and when it's shared understanding you have a real change going on (male, primary teacher).* [004]

The evolution of language registers for electronic communication creates yet another discourse, as he further reflected:

> *I believe that a new form of language develops between people when using the electronic medium that requires clarity of meaning, simplicity of concepts and patience to ensure the message is getting through. So many of our issues during the two runs of the project have been related to a misunderstanding of a concept (male, primary teacher).* [004]

However, even in a large school, the size of the school community can mean that teachers have few soul mates on particular topics of discourse:

> *So to be able to discuss learning technologies, I've found it difficult because a lot of people aren't familiar with the things that I want to do: and that's geographic information systems (male, secondary teacher).* [001]

Challenging discussion

Teachers in this study generally valued workplace harmony rather than argument and critique, perhaps missing an opportunity for learning (Boyle & Skopp, 1998). One however, saw possibilities in teachers discussing from different positions:

> *If teachers are really challenged at their core for an extended period of time, the dialogue that might be polarised to begin with eventually will come together (male, primary teacher).* [004]

Another argued for more challenging discussions and research input, particularly in professional development programs run outside school:

> *We have to start talking about our practice in a way that's not just superficial, because a lot of teacher discussion is superficial. As you move up the ladder when you go to conferences and you work in special programs, the thinking's very deep and the talk's very deep. Discussion of SILT with the researchers and other people is at another level and that's what I love about it. You know we baby teachers a lot in professional development. We give them readings that are very simple. We don't hand out research papers for teachers to read (female, secondary teacher).* [025]

She went on to suggest topics for discussion:

> *Well we need to discuss, teachers need to be allowed to have a professional discourse around the changes that technology has brought to society, including things like the digital divide and all those other sociological issues. We haven't really touched on those (female, secondary teacher).* [025]

Further, like Nias (1987) she suggested that teachers' apparent reluctance to change is related to the preservation of their sense of self — and the role of teacher — but also saw that they could help each other:

> *They're fearful about what it will do to their job, you know, how their role changes. They're not the experts anymore because you can use all kinds of software and the Internet and you can find an expert that knows more than the teacher does. That's the fear that we're facing. Teachers need to talk about that and how they envisage their job will change and how we can help them through that process (female, secondary teacher).* [025]

7.6 Teachers freely share their knowledge

Stahl's (1999) notion of unfettered sharing of knowledge among teachers, while laudable, goes against the historical and cultural practices of many, requiring the de-privatisation of practice. Isolation is of particular concern where it discourages professional conversation, hides practice and therefore removes an opportunity for others to learn (Ball, 1996). The substance of teachers' ongoing learning remains part of the tacit knowledge in many schools.

Attitudes to sharing knowledge

The notion of collective responsibility (Venezky & Davis, 2001) requires a mature sharing relationship based on trust. Teachers must be able to trust each other regarding both personal insights and professional products. Several participants raised this balance of trust and accountability. Upon reading other teachers' journals, one teacher wrote in his own:

> *I feel most privileged that the teachers have enough trust in me that they will share such incredible and personal insight into their professional practice (male, primary teacher).* [004]

Another spoke of the obligation of one teacher to another, which creates interdependence:

> *As a teacher if you observed another teacher doing that then you've got a professional obligation to go to them and say "I think the idea that you've got about using technology is really good, but can I show you some ways to use it differently so that you will be happier with the results that you get" (female, secondary teacher).* [025]

A principal also spoke of accountability in a more formal mentoring relationship:

> *It needs to be sustained and it has to have that human contact, that mentoring contact, I believe. You need to do it over a period of time if there's going to be a change in your practice. And having this sustained mentor relationship puts that onus on both the mentor and the protégé, they're accountable to each other, so they have to be able to articulate and really look at change and really try to implement it and know what they are talking about (male, primary principal).* [032]

Like time, proximity was important for many teachers. Teachers who used classrooms opening into shared resource areas such as *pods*, valued the opportunity to share, such as these two in a primary setting:

> *Female teacher: Yeah it's good. I've certainly learnt a lot from [male teacher]. "Let me tell you about this idea." This is [him] all the time. "What do you think about that?" I go "Oh that's fantastic".* [018]
>
> *Researcher: What do you learn from [female teacher]?*
>
> *[Male teacher]: It's probably just the general structure, because I'm still fairly new to teaching, just the general way you go about it.* [019]

These teachers, one very experienced and one in his first year of teaching, showed that quite different needs can be addressed through informal workplace learning in this way.

No teacher in this study was opposed to sharing information and knowledge, but some found practical constraints worked against them. In the following three extracts, a teacher who worked across two campuses of a secondary school experienced physical isolation and felt that other teachers in his team did not want to share:

> *I probably don't get as much benefit out of working with other people all the time, and I think you need to strike up a working relationship with somebody. I'm not saying there isn't anybody here that that doesn't happen with, because it does, especially at the other campus, with Year 7 and Year 8s, but for some reason at this campus, it doesn't tend to happen as much.*
>
> *What I want to try and do is get all SOSE staff contributing to the Intranet, but that's still a struggle. I don't know why that is. People have their worksheets. I don't know why they don't want to share things.*
>
> *I don't know how many times I've tried to encourage that sort of thing, over the last two and a half years, to get people to come along to meetings, to actually sit down and talk about what they do in classrooms. People aren't prepared to do it, (male, secondary teacher).* [016]

Similarly the stuff of corporate memory — the knowledge of past practice, often undocumented and tacit — was in some cases ignored, as this teacher expressed:

> *With each new broom you get the wheels being reinvented and prior knowledge, previous knowledge, is not worth anything. You know nothing. I was coordinator for three years and I have not been consulted about anything from that time period (female, secondary teacher).* [008]

Technology assists sharing

The boundary of the physical classroom was very strong, particularly for secondary teachers in this study. Rarely were two teachers seen in the one classroom with students, and most teachers reported that for most of their time with classes, they were working individually. One way to cross this boundary and overcome isolation was displayed by teachers who used video conferencing between classrooms in two schools. This was an example of teachers being opportunistic (Jackson, 1990): taking control of technology's capacity to modify the environment to serve their own purposes. During the course of the conferencing, teachers and students could see into another classroom culture, albeit briefly. One teacher described the advantage of the video:

> *The closed-door syndrome really is out there. Let's leave the door closed but let's get into the room. Teachers feel most comfortable in their own environment and that's where the practice is going to take place (male, primary teacher).* [004]

Teachers also referred to the online communities developed through the Department of Education and Training web portal or through teacher-generated email lists:

> *If you have an issue you don't have to wait until the next PD [professional development activity] that you go to, to find out the answer. You can put that question either to the individual, to the whole group, to your students, to students at the other school. And if no one knows within a hundred- or two-hundred-person group then the information then goes out on the net and people are out searching and trying to find the information from the web (male, primary teacher).* [004]

> *You see Magnet which is Science and Technology teachers, we've maintained a listserve now, so you can just post off from there and there's some people on there that are just fantastic. If you threw out a question on Magnet, you would say, "Does anyone use…? I want to know about…" and they come in (female, secondary teacher).* [008]

This is tempered by the finding in Chapter 5 that teachers are cautious in expressing unformed ideas in this medium, which can be archived and distributed.

7.7 Teachers reflect on their practice and share their reflections

Where inquiry is a stance, teachers can use a range of methods to research their own practice individually and collectively. Reflective practice serves to make connections between the daily work, its underlying assumptions and the agendas for school and social change. By virtue of the research design, the most common types of reflection were review (less formal reflection-on-action at a particular point in time) and research (more systematic reflection-on-action over a period of time) (Zeichner & Liston, 1996). Many review comments were found in teachers' journals, where they tended to analyse classroom practice and events, like these two:

> *I was quite surprised at the number of children who began an entire new presentation when all they had to do was create a new slide and continue the story. It wasn't that the children weren't clear on what to do but they thought you created a slide, saved it, then started a new presentation for the next slide. Obviously they have missed something when PowerPoint was being taught, so we re-visited some of the basic features and hopefully the confused children are back on track now. We'll see when they continue the task next week! (female, primary teacher).* [012]

> *The proformas we developed last week seemed to have had the desired effect, with students and teachers far more directed and driven and clear of the expectations we have for them. In hindsight we certainly should have had these proformas in place before we started the project. A little less open ended and a little more directed to begin the project will mean that everyone is heading in the same direction from day one. Live and learn. It could be the turning point! (male, primary teacher).* [004]

On the other hand, a busy secondary teacher commented after a conversation:

> *I don't do it enough. As this is part of the reflection process, it's something that I'll need to a lot more (female, secondary teacher).* [008]

The more systematic reflection, labelled research, was sometimes undertaken in conjunction with researchers, as this teacher described:

> *[Researcher X] is certainly one of my reflective mirrors asking the hard questions, and he also guided me through some other issues (male, primary teacher).* [004]

Journal writing

Writing in journals is one way to engage in reflection (Lukinsky, 1990), and in the absence of any other audience, can become a form of conversation with self. The teachers in the two schools this study who regularly wrote in electronic journals were part of a structured school-based project, which mandated journal writing in both 2001 and 2002. Rather than conversations with self, they saw their audience as the coordinator of the project, who described the process favourably:

> *We agreed that learning journals would be the way that teachers would document their journey through the process. Those learning journals really took shape quickly because the teachers were able to express what it is that was happening in their classroom, what it is that was happening in their own learning and changes in their practice. So they were sent off to the administrators at both schools and the administrators looked over and assisted (male, primary teacher).* [004]

These journals were based on a structured protocol (Lieberman & Miller, 2001) to which teachers responded each week. Questions included: *what did you learn this week, what new skill could you teach someone else, how did you solve problems encountered and what did you learn as a team?* In his own meta-reflection after the first project concluded, the coordinator wrote:

> *We didn't explore the learning journals as well as we could have, but we'd also like to think that journals of any sort are a very personal approach. What we want to do this time is each person involved in the project to keep a journal that includes the students, but we want to look specifically at elements within the journals. We don't want to look at it all because there are days where you walk away thinking that is just terrible but within those terrible days there is always incredible learning (male, primary teacher).* [004]

In another school, a secondary teacher described how she intended to model and encourage journal writing:

> *I've kept a reflective journal since I started to aspire to principal class. I've been working with teachers in the PRP [Professional Recognition Program] this year, the ETWR [Experienced Teacher With Responsibility] teachers and the Leading Teachers and I'm encouraging them to keep professional journals. I brought mine in to show and I think that keeping a reflective journal is really important for teachers (female, secondary teacher).* [025]

Sharing reflections

In addition to the very informal nature of teachers' conversations, there was some evidence of sharing of reflections between teachers in this study and their colleagues. In the first example, a teacher with six years' experience encapsulated the dual nature of reflection, both looking back and looking forward (Baird, 1991) in his comment:

> *I think you have to really reflect on what you are doing and why you are doing it, to make it important, make it worthwhile for yourself and for the people that you are teaching. When you have made those connections and reflections for yourself, it becomes real. Someone discusses it with you, a colleague talks to you about it and you have a real sense of moving in the same direction. Talk about successes and failures and just different things in different ways, a real obvious common ground you have got (male, primary teacher).* [003]

One secondary teacher was a member of PEEL: Project to Enhance Effective Learning, a group of teachers reflecting on practice within the school (Baird & Northfield, 1992) and found this very helpful. In another school a teacher also described reflective meetings that considered both the past and the future:

> *We discuss things that we want to cover, our successes, our failures, problems that we may have encountered or problems that we might foresee, and all the other things that come along with that like excursions and curriculum. Planning for particular subjects, planning for IT and what's our next step as well. That's the formal part of it but it's also pretty much real life, because everything is real life (female, primary teacher).* [022]

A teacher's journal entry showed that students could also be partners in reflection.

> *Have been getting a little frustrated with the progress of the project this year and was reflecting on how every thing went far more smoothly last year. Fortunately a former student dropped in for a chat and promptly reminded me that we had major issues last year. Projects did not run smoothly and we made continual mistakes as we learnt. How quickly our memories fade and the past becomes rosy! Must remember that from little things big things grow (male, primary teacher).* [004]

There were no instances of teachers reflecting on data or artefacts as Ball and Cohen (1999) suggest, or of teachers using videotape to document their own practice. Similarly, although Cochran-Smith and Lytle (2001) suggest that teachers' inquiry should also have a social purpose, connecting local knowledge to larger social, cultural and political issues, there was little evidence of this. One teacher suggested future contact with local government, but generally the data indicate that teachers in these middle years were more concerned with the local issues of practice rather than broader social issues.

7.8 Teachers innovate and document innovative practice

Teachers in this study are recognised as innovators in education, by virtue of their participation in the Successful Integration of Learning Technologies (SILT) Project. To innovate requires making new connections between knowledge and new ways of making meaning (Wenger, 1998) motivated by problems of practice (Hogarty et al., 2002). Nonaka and Takeuchi (1995) describe innovation in Japanese companies as a conversion of knowledge from outside to inside and back out in the form of new products, services and systems.

Some teachers in this study took on new knowledge from a range of sources and made new connections, creating innovative projects and practices. Such teachers tended to fly intellectually beyond the classroom (Preston, 2001), documenting their practice on school Intranets or the Internet for wider access and feedback, presenting workshops at conferences and writing articles for newsletters and journals. Most presented at SILT Project seminars in 2000 and 2001, several contributed to their school newsletters (as did students) and a few published more formally. Several teachers published evidence of

student work on the Internet. One teacher reported on the result of sharing in a newsletter item:

> *I had a girl from [another school] visiting our lab last week. She read about our Middle Years happenings in the regional newsletter and wanted to see it. She was 'blown away' by all that was going on, the facilities etc and sat in on one of [two teachers'] video-conferencing sessions. She had never seen VC happen before and thought it was great. I suggested we could 'mentor' (there's that word again) her school next year and she was right into that (female, primary teacher).* [026]

Innovation can be supported through recognition, often leading to additional resources. The *City to Surf* online collaborative mentoring project (between school B and school L) was one of four projects selected as finalists in the innovations section of the Victorian Teaching Awards 2002. It is not easy for teachers to add the preparation for such recognition on to their daily work, as this teacher described in his journal:

> *A very taxing day developing the submission, which the Principal co-authored and edited, and the Assistant Principal reviewed. Much appreciated the team approach to writing the submission… A team of three will be required to present a ten minute project brief followed by a 20 minute question and answer session conducted by eminent people (male, primary teacher).* [004]

After the presentation, he wrote again:

> *We felt that we did not present our case as well as we could have, and will need to become a lot more slick in future when asked specific questions about learning outcomes. The next time we are to present in front of a panel like this we will be far better prepared (male, primary teacher.* [004]

This comment is a reminder that the skills involved in reflecting and writing about practice are also potential areas for professional development, or that alternatively, others can be brought into the team. Hoban's (1997) inside-outside models aim to develop a community of discourse drawing upon the experience-based knowledge of teachers and the knowledge of researchers and others. The Commonwealth Department of Education, Science and Training (2002) expressed a need for researchers to record explicit knowledge, particularly the practices resulting in effective use of technologies. Several teachers in this study have embarked on a practitioner-researcher partnership

that aims to work together in a reflective relationship and take explicit knowledge to a wider audience. This gives teachers the opportunity to concentrate on their practice, as one principal commented:

> *And realistically you don't want teachers always researchers. You want to be able to present; you don't want to take them away from their core business. They're good at what they do. Their gut feeling is that what they do works, but they're constantly being asked to prove it, and that's the researcher's role (male, primary principal).* [032]

In conjunction with SILT Project researchers, teachers from four of the schools in this study presented or submitted papers for international conferences. This can have the benefit of opening their own work up to wider scrutiny, as this teacher commented via email:

> *The conference was really great. It gave me personally a chance to evaluate what we currently do at school. It was a huge eye opener in terms of what is happening with various schools around the world (female, primary teacher).* [022]

7.9 Teachers contribute to school-wide decision-making

One would expect that knowledge-building schools take advantage of the classroom experience of teachers (and students) in their decision-making processes. The Smith Report (Directorate of School Education, 1994) suggested that teachers should become involved in the decision-making about information technologies in schools, while in another state decision-making, advocacy and lobbying for change are encouraged through the competency framework (Education Queensland, 2001). Fisher claims that there is enormous scope for students themselves to become involved in redesigning existing schools through their learning tasks and that teachers are key players in this approach (Rennick, 2002). This study indicates that there is also scope for teachers to be more involved.

Design decisions

Teachers were rarely involved in school-wide decision-making regarding the physical environment and computer hardware, and where they claimed to be involved in

decision-making, their arena was circumscribed and their behaviours often compliant. They were quite involved in curriculum decision-making within the guidelines provided, but there were few indications that they felt able to act on the curriculum. Late in the study a discussion with one very active participant revealed his view that most teachers saw the curriculum as handed down by the system, rather than evolved within the school community. This reflected the concern of Cherednichenko et al. (2001) who claim that teachers lack their own discourse of learning, and may not construct curriculum because the hierarchical language of the system prevails.

Although Peterson, McCarthy, and Elmore (1996) argue that it is improvements in teacher learning, not school structure, which will reform education, teachers in this study have raised issues such as physical conditions and entrenched school arrangements that certainly appear to diminish potential improvements. One principal spoke of the Department's responsibility to change physical structures:

> *That's probably one of the big challenges for the Department of Education and the Government: the fact that the schools were built for the industrial age and they really don't match the kind of teaching that we are now doing and that we will need to do into the next ten to fifteen years. And yes, they're building new schools on better models but I still think they need to go further, it needs to be much more open, so that's a challenge (female, primary principal).* [023]

Some teachers took control of the decisions regarding their own classrooms, as in this primary school where student feedback was also considered:

> *They will build their rooms as they see fit and they will build the room that best suits their teaching, which I think is a healthy environment. The teachers are constantly changing, reconstructing their rooms depending on what their learning needs are (male, primary teacher).* [004]

Being involved in decision-making does not mean, however, that there will be easy solutions, and experimentation is likely to continue for some time. Teachers in two schools explained how changes in physical arrangements have been made in order to maximise access:

> *We have gone from having a lab with 25 or 30 computers in there to now dispersing those. We do have a core in that one classroom now because we also do community access stuff, so there are enough computers to run an evening adult course but we've taken those computers out and increased them in the classroom (female, primary teacher).* [021]

> *Part of our SOSE doctrine, I guess, was to have three computers in a number of rooms, which we have. So if I am in there, then the kids can work over there or they can go back. It's very much like a primary school environment where they can choose to sit there, or go over there (female, secondary teacher).* [008]

Two teachers who share a new *pod* of computers reflected on the arrangement in terms of their teaching but had not been involved in the decision to build it:

> *Male teacher: I don't mind it. I would like it more if the wall wasn't there. I like the half wall, I'd like to have the half wall, so it still hides the back of the computers and you can still use the other side.* [019]
>
> *Researcher: It's a very small window, isn't it?*
>
> *Female teacher: Yes and it's never open unless you're giving them sign language through it or something.* [018]
>
> *Male teacher: And because it is a small room, if you do have it open it echoes. They don't have to speak loudly and it echoes through.* [019]

Management decisions

In terms of managing people, a secondary teacher mentioned the possibility of a small change that she envisaged, but had not implemented:

> *I mean it's better to have 50 or 40 kids in the room and two teachers, one who's able to work with the kids who need some extension, rather than one teacher in a room and kids helping other kids while the teacher wanders around not doing anything (female, secondary teacher).* [025]

Teachers are aware that they need to have some sense of the potential of technology if they are to make decisions about investment in hardware and software, as this teacher explained in relation to a software choice:

> *It's also getting the teachers to work out what sort of technology is appropriate. [Another teacher] brought up the point about*

> *Dingo [an email/web client]. Now they use Dingo for students because you can censor the sites, whereas as all the staff who are using e-mail use Eudora because you can open up attached files easily. With Dingo it's not as easy to do. And those sorts of decisions about what type of software or what type of program are intrinsic in these decisions about use of technology (male, secondary teacher).* [001]

In some schools decisions regarding technology in the learning environment are structurally separate from other curriculum decisions, and links depend on individual teachers, as in this case:

> *I think there probably hasn't been enough input from other people… because at this school some of the better people in technology, for example, a French teacher knows as much as the technology coordinator, in terms of computers, so he's driven it in one direction and a couple of the other staff have been knowledgeable about it, so there has been some debate (male, secondary teacher).* [001]

However some teachers in the study felt unable to influence decision-making at all, such as these secondary teachers:

> *I still haven't got any technology down in the junior site, which was promised three years ago. Every time we consult someone, "Yes, it's coming, it's coming" or "It's too expensive to change the wires" (female, secondary teacher).* [011]

> *They were going all right for a while, but I believe that in the last term we've gone backwards again. We've got new rooms, new technology, but I believe that certain subjects have been invented. As curriculum coordinator, I need to do a lot more reading on ICT across all KLAs, Years 7-9. That would be more beneficial than running silly one-off classes in Yr 9 (female, secondary teacher).* [008]

In spite of commitments to community, teachers rarely mentioned parents as stakeholders in the decision-making. One however, realised that they might not always want to change teaching practice:

> *I think too it's been an education process for our parents. They all seem to think they're experts because they've all had some form of education, and if it was positive they think the way they were educated is the right way to go (female, primary teacher).* [021]

7.10 Teachers develop theory from their practice

For Dewey (1933) the investigation of practice, and reflection on practice and inquiry, is the driver for the generation of theory. On the other hand, where the professional discourse is strongly influenced by system language (Cherednichenko et al., 2001), teachers are likely to develop espoused theories that they articulate and theories-in-use that are demonstrated by their behaviour (Argyris & Schon, 1974). Time for reflection can assist teachers in better articulating personal theories (Griffiths & Tann, 1992). Nonaka and Takeuchi (1995) see an interactive relationship between theory and practice and Wenger (1998) further suggests that communities of practice are places where people develop, negotiate and share theories.

In general, apart from the learning theories reported in Chapter 4, there was little evidence of teachers articulating a link between their practice and the continual development of their educational theories, indicating that these may be in the realm of tacit knowledge. While not articulating a personal theory, one participant felt that more attention should be given to understanding learning:

> *Teachers in positions of responsibility in schools and administrators need to think about the ways that students learn and the way the classroom teaching impacts on the way students learn. If that means we have a careful discussion about why we have a textbook then you'll need to do that. I think it needs to be that basic (female, secondary teacher).* [025]

Another secondary teacher expressed a view on management based on her experience:

> *One of our big arguments is that Years 7-10 ICT should be across the curriculum (female, secondary teacher).* [008]

As there were no explicit conversation or journal prompts to reveal teachers' theory generation, the data were considered in detail to identify phrases such as *I came to realise*, *I think*, *I find* (after Cherednichenko et al., 2001; O'Rourke, 2002) or models which could be taken as indicators of theorising. Teachers in this study alluded to their learning theories when talking about their practice, although holistic or comprehensive theories based on practice were rarely stated explicitly. One principal raised a fundamental question:

> *Well I think you have to, as a society, say "What are we going to do for people? Are schools important as they currently stand?" (female, primary principal).* [024]

In another school a model for learning was presented in concentric circles, with *understanding* in the centre. In describing this model, one teacher stated:

> *We call it gathering, knowledge, understanding: that's our target. At the core we are looking to create understandings when we teach. Around that is there's knowledge, which we want the students to achieve and to collect, and then outside of that there are the skills and a lot of that is learning technology skills (male, primary teacher).* [004]

While he clearly accepted the model, his personal input to it was not known. A secondary teacher expressed her theory more tentatively, indicating that it was not based in her practice, but emanated from outside:

> *I think the theory is that you only want to learn if you perceive it as being relevant to yourself (female, secondary teacher).* [007]

Teachers in this study did not reveal a significant gap between espoused theories and theories-in-use. Those who articulated a belief in student autonomy, for example, tended to encourage this in their practice. Although there were few detailed examples of teachers articulating personal learning theories in the data, of the fifteen teachers who returned a completed map of knowledge building (Table 8.2, Chapter 8) half claimed that they generated theories about learning from their practice. It seems, therefore, that these are in the realm of tacit knowledge, not shared in general discourse.

Discussion

In summary, and bearing in mind the basis of propositions derived from Bassey's (2001) singularities, this chapter has found that in relation to improving practice it appears likely that teachers committed to knowledge building:

- encourage each other in new ways of working and learning
- frame personal and social goals for their learning
- make time for sustained professional learning in the workplace
- learn through play
- learn through dialogue and conversation
- freely share their knowledge

- reflect on their practice and share their reflections
- innovate and document innovative practice
- contribute to school-wide decision-making
- develop theory from their practice.

The chapter has focused on the professional learning that takes place in teachers' workplaces, either in the classroom, within the school: in Hoban's (1997) terms, inside-in. Other forms or models of professional development are only mentioned in passing. This is not to say however, that the teachers in this study are only inward-looking. Teachers have taken on the need for continual learning and they often encourage each other to try new ideas and new practices, sowing the seeds of a relationship of interdependence (Venezky & Davis, 2001). Neither is it always the case that workplace professional development activities suit the needs and learning styles of all participants. The findings of this chapter clearly show several ways in which knowledge building can occur where a school culture supports professional learning. They indicate that some structures, such as goals, plans, and scheduled time, are useful, particularly where they are open enough to accommodate just-in-time learning opportunities. Like their students, teachers need a purpose for learning, and where this is evident, they are motivated. Through the statewide system of performance management and professional development planning — a pressure mechanism (Fullan, 1993) — teachers are expected to do this, but it is at the school level where goals are realised, with the support of the leaders and other teachers. Teachers in this study document their goals, but are less likely to document their achievements, thus missing an opportunity for knowledge building. It seems that they still have a focus on inputs for their own learning, while they have moved to an outcomes focus for their students. It would be difficult to manage the collective competencies of the staff if they are not known.

Teachers' concerns about lack of time are well known, but are not insurmountable. Where teachers act individually in the current role definitions it is unlikely that they will be able to maintain high performance across all roles, and will feel inordinately pressed for time. The findings reveal instances where time is gained by opening up classrooms to teacher learning opportunities and collaboration, and where teachers are creative in their management of time for professional learning, both formal and informal. However the

attempts to find time are constrained by the existing school culture and timetabling and teachers' expectations of their roles. These teachers did not mention industrial agreements, although they influence school culture.

The openness afforded by creative scheduling is matched in some cases by informal creative activity. Teachers reported that their learning about, and with, computers often occurred through individual exploration and play at times of their own choice, generally because they had access to a personal laptop computer. They also learn through talking with other teachers, formally and informally, although a culture of debate is rare. The existence of shared local discourse means that teachers, particularly in primary schools, confidently engage in conversations about learning, but the findings indicate some barriers to wider discussion and debate. In the absence of a shared discourse at a wider scale, teachers tend to use the system's language, which can entrench ways of thinking and stifle creativity. Many teachers realise the benefits of sharing their knowledge both within the school and more widely in the profession, but even some of the most active knowledge builders in this study expressed reservations. These could be explained by differing levels of trust, either in self or others, and are exemplified in the differential use of online communication, opening up of classrooms and public presentations about their work. Teachers using email lists are exposing thoughts and practice to a wider audience than their workplace colleagues, which requires confidence in themselves, as well as trust in the audience, and in some cases, a knowledge of the appropriate discourse. Those who do not use online communication would need to see a purpose for it, as well as having access to the hardware and infrastructure, if a critical mass were to be reached, as Stahl (1999) suggests.

Several findings relate to teachers' involvement in reflective practice, either individually or collectively (particularly 7.3, 7.5 and 7.7). Reflection has become an often-used term, so that many teachers believe they are engaging in reflective practice, when, in Baird's (1991) terms, they are merely thinking. Nevertheless, many teachers in this study had commenced the practice of reflection: some through generic reflection (Zeichner & Liston, 1996)) and others either through journal-writing or discussion groups based on

the teaching team or with a group of like-minded people (the PEEL approach). This assists teachers to share tacit knowledge (Nonaka & Takeuchi, 1995) and in spiral fashion to build theory from their practice: the first phase of knowledge creation. However this appears to be a fairly private activity. If, as Nonaka and Takeuchi suggest, tacit knowledge is even more important than explicit knowledge in terms of knowledge creation, teachers need to find ways to express this. The new partnerships developing between teachers in this study and researchers are crossing some entrenched boundaries and have the potential to create shared discourse, and to allow teachers to focus on their teaching roles while research partners gather data, reflect with them and document new knowledge.

In spite of a conversation prompt regarding Beare's notion of disaggregating teachers' roles, most teachers did not envisage change. Even those teachers who were not constrained by structures and frameworks tended to influence only their own physical domains, rather than actively influencing school wide decision-making.

This chapter has identified some of the ways in which teachers improve their teaching practice within the workplace, linking the roles of designing the learning environment, managing people and resources, and mediating student learning described in the previous chapters. It records aspects of school-based professional development, and as such informs the study of teachers' roles and professional learning. In the next chapter the four roles will be brought together to provide a comprehensive description of teachers' professional practice and will be considered in terms of knowledge building.

Chapter 8 : Aspects of a professional learning culture for knowledge building

This chapter returns to the purpose set out in Chapter 1 — to identify the forms of professional practice that enhance knowledge sharing and knowledge building — and responds to the three research questions outlined there. Knowledge building was defined in Chapter 2 as activity directed towards the creation of knowledge, in the form of products, principles and theories, often through viewing current information and knowledge from different perspectives and making new connections. It is seen as the task of communities of practice in this study, as indicated in Figure 8.1, which is a reprise of the conceptual framework first presented in Chapter 3.

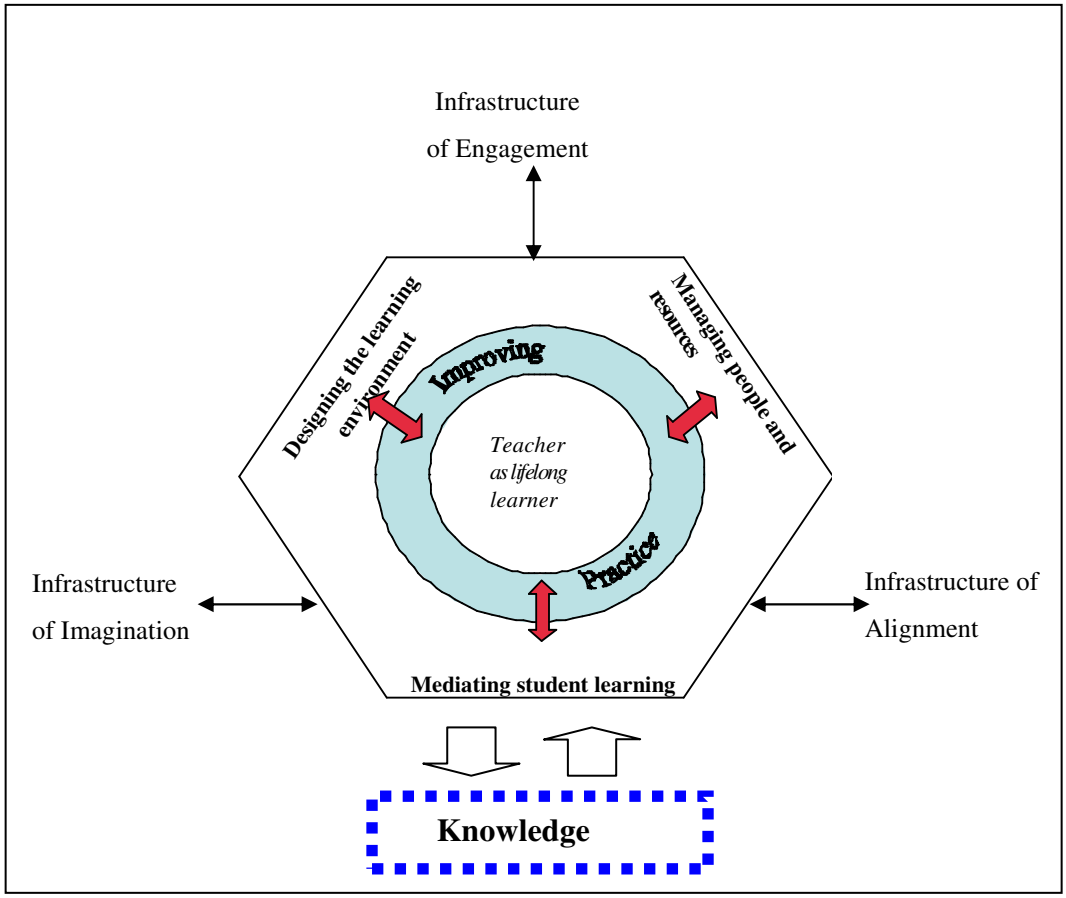


Figure 8.1 Conceptual framework

Using an ethnographic methodology, particularly engaging in processes of reflection with teachers, the study has identified, with teachers, how they see their roles in the categories of designing the learning environment, managing people and resources, mediating student learning and improving practice. In a school, they are at once teachers and learners, acting on and reacting to the context, in order to improve practice, both individually and collectively.

The first part of this chapter considers the findings of Chapters 4 to 7, which described and analysed the current and emerging teacher roles found in classrooms using computers, and indicated evidence of knowledge building within contexts characterised by collaboration, flexibility and openness. As a result a framework outlining teachers' roles has been developed. The second part of the chapter reflects on and reanalyses this framework in light of Wenger's (1998) theory of communities of practice, particularly looking at his learning architecture with its infrastructures of engagement, imagination and alignment, to identify the relationship between the theory and the practice of knowledge building. The third part of the chapter suggests implications of the findings for teacher development policy and pre-service education.

Teachers' roles and relationships

The first aim of the research, noted in Chapter 1, was to describe the current and emerging teacher roles found in classrooms using computers. This study contributes to the current state of knowledge by presenting rich descriptions, by teachers, of the roles they play in the changing context. It makes explicit the tacit knowledge gained through teachers' experience and makes connections between this knowledge and current influences on education.

Rather than dramatically new roles with the introduction of technology, the findings indicate that teachers are developing new behaviours and new configurations of roles, with the support of communication technologies. This conclusion is supported by the findings relating to both teacher behaviour and school arrangements. During the course of the study it became clear that the participant teachers generally saw themselves as facilitators of student learning, and frequently acted as such. However there was some

evidence of change in the narrow structural relationships of one teacher, one class and a desire to replace fragmented connections with a deeper community connectedness. This led to a realisation that rather than describing the individual teacher as facilitator in a student-centred classroom, as much of the recent literature argues (Fisher et al., 1996; Jones et al., 1995; Lang et al., 1995; Means & Olsen, 1994; Tinkler et al., 1996), and urging teachers to move towards this approach, the emerging roles are better described by new terms, including collective terms that emphasise the need for teams of experts under the umbrella of knowledge builders. Table 8.1 suggests one way of doing this.

Table 8.1 Four types of relationship between teachers and students

	Teacher	**Teachers**
Students	1. One-on-one	3. Case management
Students	2. Collaboration	4. Knowledge-building

The relationship between teachers and students is manifest in various ways and in each case a teacher can have a student-centred approach and use facilitating behaviours. Types 1 and 2 are quite common in the classrooms observed, while Type 3 is more usual where students have special needs. The new development identified in this study is Type 4: Knowledge-building, based on networks of relationships between multiple teachers and multiple learners. This is not to be confused with the common secondary model of many teachers operating within discipline structures relating to each class of students.

The major point of difference is that while the individual teacher can facilitate student learning in isolation from other teachers, in the definition proposed by this study, teachers as knowledge builders cannot. Rather than teacher- or student-centredness, the focus is on learning as the process of building knowledge. Knowledge-building teachers work together to design and manage the learning environment to increase the sum of community knowledge, through mediating student learning. They look outward to broker links both locally and globally. Individual student outcomes are not ignored, but they are seen also as part of the community's knowledge. Teachers continue to see themselves as learners, but the knowledge they create is contributed to the collective

competence of the profession, and valued as such. This study shows that the shift is occurring gradually, with areas of overlap, as Figure 8.2 is designed to indicate.

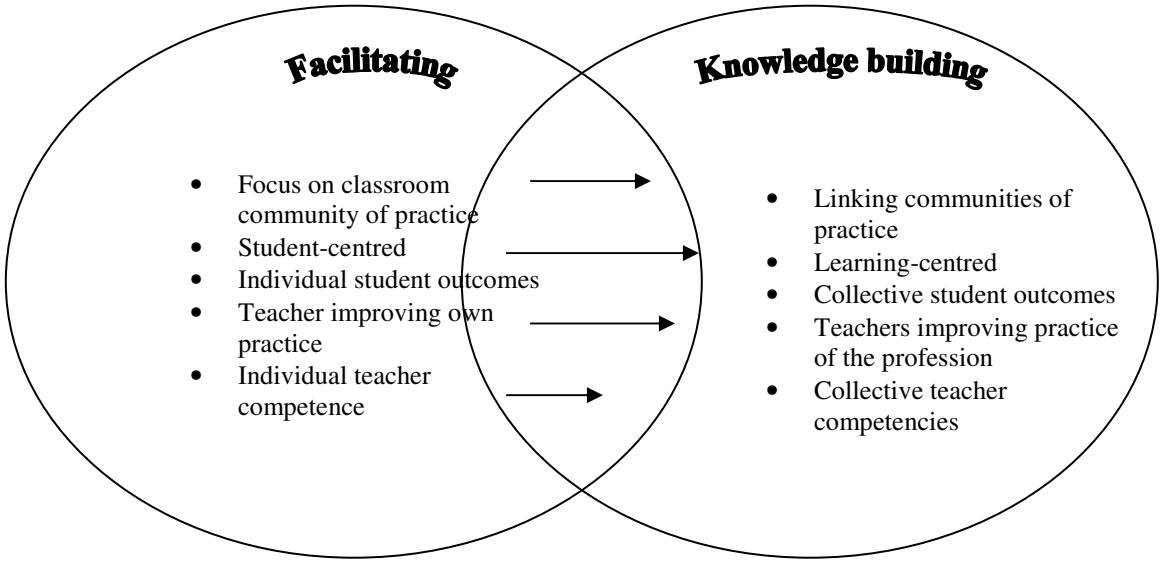


Figure 8.2 From facilitating to knowledge building

Four roles of teachers

Within this context, teachers' roles fall into four areas: *designing the learning environment, managing people and resources, mediating learning* and *improving practice*, and in this study they have been described in terms of their capacity for knowledge building. The detailed descriptions are intended to assist teachers, those intending to become teachers, and their teachers in pre-service institutions, to review teaching and plan for the future. They show that many teachers are attempting to create knowledge-building communities, in spite of perceived organisational and system constraints. In the current study these roles were all based in the physical classroom, but they have the capacity to be developed in new time and space arrangements, and are therefore useful in considerations of the future of teachers and teaching. As discussed in Chapter 3, a study such as this with the intention of providing advice to teachers, schools and systems should tackle the issue of what *could be*, so it was felt important to capture and report on single instances, because if an occurrence supporting knowledge building is found in one setting, it might be able to be implemented in another. All findings from

Chapters 4 to 7 are summarised in Table 8.2 to indicate the characteristics (here called *elements*) of the four roles.

Table 8.2 Key elements of teachers' roles in knowledge building

Designing	Managing	Mediating	Improving
Teachers' understandings about student learning inform design	Teachers involve students in management	Teachers help students learn how to learn	Teachers encourage each other in new ways of working and learning
Teachers incorporate, but are not bound by, curriculum frameworks documents	Teachers encourage student motivation through intrinsic means	Teachers share teaching and learning with students	Teachers frame personal and social goals for their learning
Teachers share a common discourse of planning	Teachers model collaborative knowledge-building and management practices	Teachers and students monitor and assess learning together	Teachers make time for sustained professional learning in the workplace
Teachers have a clear purpose for technology use	Teachers manage technology as a resource for students to build knowledge	Teachers build on students' prior experience	Teachers learn through play
Teachers involve students in curriculum planning	Teachers manage relationships between people for authentic learning	Teachers facilitate connections between people	Teachers learn through dialogue and conversation
Teachers design in professional collaboration within and across schools	Teachers manage connections across boundaries	Teachers focus on knowledge-building activities	Teachers freely share their knowledge
Teachers plan purposeful tasks which require collaboration between students		Teachers scaffold student learning individually and collectively	Teachers reflect on their practice and share their reflections
Teachers cross the boundaries between key learning areas		Teachers and learners talk together to increase learning	Teachers innovate and document innovative practice
Teachers design for open-ended learning			Teachers contribute to school-wide decision-making
			Teachers develop theory from their practice

These elements form a picture of the teachers of the future, thus providing a set of goals or expectations that will be useful to practitioners in several ways. For individual teachers they form a zone of proximal development for professional learning; schools can use them for planning; while education systems wishing to promote innovation in

and across communities of practice can assess policy decisions in light of these elements. Summaries of each role description follow.

Designing the learning environment

Teachers' designing role involves planning physical environments at the scale of both the classroom and the school, including the use of horizontal and vertical space, layout of furniture (fixed and movable), and the extent and site of fixed computer cabling and network points. It also includes planning the learning space created by digital technologies and electronic communication, through clarifying a purpose for these resources and establishing appropriate access. These and other design decisions are based on teachers' espoused learning theories, currently influenced by cognitive psychology (for example, using multiple intelligences) and social constructivism (for example, employing collaborative group work).

Generally, the influence of the teachers in this study was felt in the classroom rather than across the school, except where a teacher held a position in which input to decision-making was expected. The capacity of secondary teachers to influence design — even of the classrooms where they taught — was more limited than for primary teachers, as they moved from room to room throughout the week. A whole-school approach to design, in which all teachers' contributions of theory and practice were welcomed, was rarely evident. Teachers' designing role also involves planning the curriculum within mandated statewide guidelines (which allow for a shared discourse) and making decisions regarding student activities that are based on consumption, (re)production and creation. Teachers using a constructivist approach focus more on designing open-ended tasks — requiring (re)production and creation as described in Chapter 2 — which require multiple perspectives gained through student collaboration. Similarly, they design activities that cross the boundaries of the Key Learning Areas rather than confining themselves to specific disciplines. These teachers see the curriculum frameworks documents as useful structures of support for their curriculum planning. In this study, teachers tended to collaborate with their colleagues in the school, particularly in primary settings, but compared with the potential suggested in the literature (Fisher, 2001;

Scardamalia & Bereiter, 1999), only involved students in designing the learning environment in relatively limited ways.

Managing people and resources

Managing people and resources, the second role identified in this study, takes place in the designed context. In this role, teachers focus on managing students, but other people such as teachers, technical support staff and outside experts are increasingly included in the human resources available. Teachers who espouse student autonomy as a goal involve students in management decisions such as organising their tasks (through teacher-student contracts or individual learning plans) and organising their work groups and teams. Unlike historical views of teacher/whole class relationships, teachers orchestrate the work of students as individuals, small groups and teams, and only sometimes as a whole class. Extrinsic motivation as discussed in the literature was rarely found, because in their designing role teachers planned purposeful tasks that engaged students — especially where they knew their students well — and in their managing role they involved students in making decisions about their work. Similarly, in their mediating role, where teachers involved students in teaching and learning, and built on their prior experience, this led to intrinsic motivation. Therefore the element of encouraging student motivation could be placed in each role, or even removed, as it is a consequence of other elements.

Knowledge-building teachers use technology as a means of communicating within and across boundaries, testing ideas, producing knowledge objects and storing these over time. Someone must manage access to the technology resources whether they are available in the classroom, in a nearby pod or in a remote location, and this task currently takes a great deal of teachers' time. Likewise, the equipment must be maintained to function properly when required, and only in some cases were there staff other than teachers available to assist. Some teachers in this study found that collaboration between teachers and with other staff and professionals in managing people and resources was important in increasing efficiency, building teamwork and sharing knowledge. Even where it was difficult to manage new uses of technology and external relationships, teachers saw it as part of authentic practice.

Mediating student learning

Teachers' role in mediating learning also takes place in the designed context and is influenced both by the design and management decisions. It hinges on the teaching-and-learning process (Mercer & Fisher, 1998) which is clearly shared between teachers and students in classrooms using computers, making the classroom focus one of learning rather than either teacher- or student-centredness. Teachers thus help students to learn about learning while they engage in the work of the class, which is activity-based, leading to an expanded *pool of knowledge*. Teachers have an important part to play in identifying and addressing the prior experience of students and using their knowledge of learning theories (such as Vygotsky's zone of proximal development) to scaffold learning. They also engage continually in monitoring and assessing student learning, and giving feedback. In the mediating role, teachers encourage communication through talk (dialogue and conversation), both face-to-face and electronic, between all types of people involved in the learning process. Teachers have particular expertise in talking with students, individually or in groups, to develop reflection, draw out learnings, challenge and question processes and outcomes. Most in this study held the belief that social connectedness is important for learners, and this was manifest in their interactions with students and, in some cases, in situating learning opportunities in a real context.

Improving practice

This role is the workplace learning role of teachers, and one in which they work together to improve professional practice, through increasing personal and collective skills and knowledge and trying new ways of school organisation. Knowledge-building teachers and leaders encourage and support each other in this work, and in setting goals for development that benefit individuals, the school and the broader society. To achieve these goals, knowledge-building teachers take control of the time available, such as changing school arrangements to allow for group reflection. This study showed that this can rarely be done individually, as it requires commitment from leaders and other teachers.

Like students, teachers learn through open-ended exploration, often termed *play*, especially when exploring the potential of technology. They also learn through talking together, a process of sharing tacit and explicit knowledge and developing a local

discourse in addition to the often-used discourse of the system. Teachers in this study tended to prefer harmonious discourse rather than the dialectic and debate, which, like the pearl in the oyster, can have valuable outcomes for community knowledge. The historical isolation of teachers in their work is being replaced by a more collaborative approach to improving practice, particularly in the primary schools in this study. Teachers are using the different means of communication afforded by technology to share boundary objects and knowledge products, but some are tentative about sharing tacit knowledge in forms such as email, which can be archived. Most teachers in this study engaged in reflection-on-action and several wrote personal reflective journals in which they reviewed practice and, in some cases, anticipated future action. Generally however, reflections reiterated explicit knowledge rather than revealing tacit knowledge. Knowledge-building teachers innovate by exploring new ways of making meaning. They document their experience in print and electronic repositories and present their new knowledge at workshops and conferences, often in conjunction with researchers. Many teachers in this study used one or more of these ways of sharing innovative practice. However, they were less likely to use their knowledge to contribute to decision-making in the school, or to articulate their developing theoretical knowledge based on their practice.

Knowledge building in communities of practice

The second aim of this study — to establish the extent of knowledge building and the conditions under which it occurs in each of the identified roles of teachers — was addressed in Chapters 4 to 7. The first three roles — designing the learning environment, managing people and resources, and mediating student learning — have potential for the construction of knowledge between teachers and students, among students and among teachers. The fourth, improving practice, focuses on teachers working together and learning with their students. Practice is the social production of meaning and the source of coherence of a community, and is itself a learning process (Wenger, 1998). Given the calls for teachers to work together to build knowledge in communities of practice (Hord, 1997; Johnson, 1996; Retallick et al., 1999), the potential for knowledge building was ascertained by holding the findings presented in Table 8.2 up to the scrutiny of Wenger's theory of communities of practice and the literature reviewed in Chapter 2. The intention

was to identify behaviours that could progress knowledge building, remembering that early in the life of a knowledge-building community only a few aspects of knowledge building might be present (Van Aalst & Hill, 2001), and to identify aspects that are missing in the structure of Table 8.2, in order to make it a more useful tool. The elements of teacher's roles are therefore reordered in Tables 8.3, 8.4 and 8.5 to show how they support Wenger's facilities of engagement, imagination and alignment. The purpose of this exercise is not to test the theory as a causal model, but to use its potential to describe aspects of schools as social organisations. As a result the study fleshes out the notion of communities of practice and points to how such communities can be enhanced in and across schools.

While the fit between the findings of this study and Wenger's architecture is not simple or neat, this is not necessary for my purpose. Wenger suggests that his architecture is a framework for asking how a specific spatial arrangement, network or curriculum provides facilities that support engagement, imagination and alignment as described in Chapter 2. This test is here applied to the findings within each role. The findings are taken as a picture of authentic practice in that they exist in one or more schools and among one or more teachers in the study. Analysing the findings of the four roles of teachers within such a social theory is based on the assumption that teachers' roles have a social purpose. They are considered at both the levels of the classroom community of practice and the professional community, on the further assumption that where the characteristics of communities of practice are well developed, knowledge building will result.

Facilities of Engagement

Engagement refers in a general sense to bringing people together to work, and encompasses three facilities: mutuality, competence and continuity, as discussed in Chapter 2. The findings that support these facilities for each of the roles are shown in Table 8.3, numbered to allow for cross-referencing to their relevant chapters.

Table 8.3 How teachers' roles support engagement

	Engagement

Designing	***Mutuality*** 4.1 Teachers' understandings about student learning inform design 4.5 Teachers involve students in curriculum planning 4.6 Teachers design in professional collaboration 4.8 Teachers cross KLA boundaries
	Competence 4.3 Teachers share a common discourse of planning
	Continuity 4.3 Teachers share a common discourse of planning
Managing	***Mutuality*** 5.1 Teachers involve students in management 5.3 Teachers model collaborative management practices 5.4 Teachers manage technology as a resource for students to build knowledge 5.6 Teachers manage connections across boundaries
	Competence 5.1 Teachers involve students in management 5.2 Teachers encourage student motivation through intrinsic means
	Continuity 5.4 Teachers manage technology as a resource for students to build knowledge
Mediating	***Mutuality*** 6.2 Teachers share teaching and learning with students 6.3 Teachers and students monitor and assess learning together
	Competence 6.7 Teachers scaffold student learning individually and collectively
	Continuity 6.4 Teachers build on students prior experience 6.7 Teachers scaffold learning
Improving	***Mutuality*** 7.6 Teachers freely share their knowledge 7.1 Teachers encourage each other in new ways of working and learning
	Competence 7.2 Teachers frame personal and social goals for their learning
	Continuity 7.8 Teachers innovate and document innovative practice

Mutuality

In their designing, managing and mediating roles, teachers clearly focus on encouraging engagement through mutuality, which requires spaces for interaction, participation in joint tasks and the concept of peripherality, particularly through boundary encounters. Teachers intentionally design and manage the physical space of classrooms and the virtual space of Intranets for interaction with and between known students, particularly in primary schools. These class groups form bounded communities. Teachers in this study all believed that physical interaction between members of a community was essential, even where electronic interaction was possible, expressed by one principal as *"that real need for the social aspect of what we do, the face-to-face connection with*

kids" (Chapter 6). The geography of the schools in this study creates strong physical boundaries, underlined by the timetable, which generally offers (and requires) physical interaction only from about 8 am until 3 pm, or 5 pm at the latest. In secondary schools the timetable forces short rotations through different communities of practice such as SOSE (Studies of Society and The Environment) or Science over the course of a day. However, strong boundaries created by the reification of the curriculum's Key Learning Areas can be crossed as people, particularly students, participate in multiple communities of practice, and bring knowledge from one to another.

Within these boundaries teachers also involve students to varying extents in joint tasks in designing, managing and mediating their learning (for example, teaching other students, self-assessment). This can be interpreted as a constructivist, student-centred approach. Joint tasks imply a shared sense of purpose and in some cases collaboration. While students are not frequently involved in designing the physical learning environment with teachers, they are involved in designing their curriculum to the extent of developing topics for inquiry and choosing forms of presentation. Teachers also involve students in management decisions about who to work with and how to access resources, and in the processes of teaching and learning. By sharing their professional expertise or knowledge of teaching practice, teachers are already changing their roles and in some cases, bringing students into expert status in the community.

Technology provides a means of increasing the learning space and time both locally and globally through email, Intranet and chat rooms that can be used inside and outside the class, especially where students have access to computers at home. Peripherality occurs when students are encouraged to relate to experts outside the community of practice, and as teachers scaffold learning in various ways the students move towards expertise in particular domain areas. These activities deepen feelings of membership and connectedness in the classroom community for both teachers and students, which are matched in some cases by teachers working in constellations of practice across the school. In the physical location or in virtual space, and particularly in primary schools in this study, there are some teachers who engage in joint tasks (particularly in their

designing role) through planning together and in peripherality through boundary encounters, operating across the boundaries of classroom walls and of the key learning areas mandated by curriculum frameworks. Such teacher-brokers disseminate knowledge and build new knowledge through new connections.

Competence

The second facility of engagement is competence, incorporating in this case the actual work of the classroom community: applying skills, making decisions, being accountable and using tools for efficiency. Much of the managing role supports competence, particularly where students are involved. Most teachers displayed trust in their students to make decisions about their own learning, albeit to varying extents. This can have the effect of increasing student motivation and can enhance self-esteem, confidence and feelings of security. The capacity afforded by technology allows students to take charge of their learning, to increase their knowledgeability and to explore new territories.

In mediating learning in the knowledge-building classroom, competence is achieved through building on students' diverse cultures and knowledgeability and challenging their understanding within their zones of proximal development. Many teachers in this study worked hard at doing this, but found it difficult where contact was fragmented. It was more evident in primary than in secondary schools that teachers knew their students well, because of the more extensive contact and in some cases, shared responsibility. Whatever the setting, where teachers and students constantly monitored progress together, they also contributed to the competence of the community through participation.

All teachers in this study considered that they were also learners and in their role of improving practice, set personal goals which, when achieved, added to the competence of the community. Teachers who actively participated in sharing their knowledge and competence with other teachers had a sense of control over their own learning and were also able to devise and engage in meaningful activities with other communities in the school and beyond.

Continuity

Continuity includes the development of shared practices and commitment both to the work and to each other, and was evident in several ways in the classrooms and schools in this study. There were some examples of the reification of processes, through documentation of local curriculum and procedures, although in Hargreaves's (1999) terms, documentation was relatively scarce within these schools. Teachers and students in both primary and secondary schools were more likely to use Intranets rather than the Internet as a repository for archiving knowledge products, but this tended to be short-term, due in part to restrictions on server capacity that led to regular cleaning out of files.

Where teachers document their processes and products they not only make their tacit knowledge explicit, but they reify the processes and products and contribute to a sense of history. In one school, for example, a teacher stated "*There is a lot of talking and a lot of role modelling"* (Chapter 7), but reflected in his journal in relation to his own recent experience **"***How quickly our memories fade and the past becomes rosy!"* (Chapter 7). Teachers who freely shared their knowledge to improve practice helped to accumulate the history of shared practice and to develop a common professional enterprise, but this tended to be most common within schools than across their boundaries.

Principals and teachers placed high value on maintaining a sense of continuity in the school, even where classroom contact was fragmented. This could also be interpreted as clinging to the status quo. At a smaller scale, teachers enhanced continuity (of learning) through designing and managing for just-in-time access to computers and communication technology. In designing the learning environment and mediating learning, and to some extent through managing resources, teachers encouraged generational encounters that enhance continuity, such as building on students' prior knowledge, and valuing parents, grandparents and industry partners in the learning process. However, continuity was generally not expressed as a purpose of such activities.

Wenger acknowledges that the boundedness of engagement might seem like a limitation, but argues that it empowers people to negotiate their enterprise and thus to shape the context in which they can construct and experience an identity of competence. Teachers in this study saw engagement as physical connectedness, supported but not replaceable by virtual connections, and providing students with a safe and secure environment for learning and constructing identity.

Facilities of Imagination

Table 8.4 shows how the findings of this study support the development of new images of self and of the world. Wenger's term, *imagination,* refers to materials and experiences with which people build an image of the world and themselves, and also encompasses three facilities: orientation (of time, space, meaning and power), reflection and exploration.

Table 8.4 How teachers' roles support imagination

	Imagination
Designing	***Orientation*** 4.1 Teachers understandings about student learning inform design 4.2 Teachers incorporate, but are not bound by, CSF documents 4.3 Teachers share a common discourse of planning
	Reflection 4.5 Teachers involve students in curriculum planning
	Exploration 4.2 Teachers incorporate, but are not bound by, CSF documents 4.7 Teachers plan purposeful tasks 4.9 Teachers design for open ended learning
Managing	***Orientation*** 5.4 Teachers involve students in management 5.5 Teachers manage relationships between people for authentic learning
	Reflection
	Exploration 5.6 Teachers manage connections across boundaries
Mediating	***Orientation*** 6.1 Teachers help students learn how to learn 6.3 Teachers and students monitor and assess learning together 6.4 Teachers build on students' prior experience
	Reflection 6.3 Teachers and students monitor and assess learning together
	Exploration 6.6 Teachers focus on knowledge-building activities
Improving	***Orientation*** 7.5 Teachers learn through dialogue and conversation
	Reflection 7.3 Teachers make time for sustained professional learning 7.10 Teachers develop theory from their practice
	Exploration 7.4 Teachers learn through play 7.8 Teachers innovate and document innovative practice

Orientation

The focus here is on locating self and learning about a wider world, characterised by the strong feelings of connectedness accompanied by outward looking behaviours, as mentioned by several teachers in this study. Many encouraged a sense of belonging to a strong community and explicit learning about self in order to grow and develop. This was particularly evident among the primary teachers, perhaps because their culture often models collaboration and the curriculum is student- rather than discipline-centred. Although the individualism and fragmentation characteristic of secondary schools makes

it difficult, teachers encouraged connectedness through communication technologies and saw the high quality of knowledge objects that students produced as contributing to the self-esteem of both teachers and students.

In their managing and mediating roles, teachers displayed a capacity to share power with students, by encouraging student self-management and self-assessment. Among teachers, issues of power were alluded to in terms of leadership and control of resources, but rarely made explicit, indicating that they are primarily part of the tacit knowledge of school communities. For this reason some teachers felt disempowered and therefore in Wenger's terms, disoriented. This could be addressed at the school level, particularly by leaders.

Wenger does not focus only on a geographic community based on locality, proximity and distance, arguing that the relations that constitute practice are primarily defined by learning, thus opening the concept of community of practice to the collaborative space afforded by communications technologies. In terms of designing the learning environment and improving their own practice, some teachers in this study were particularly enthusiastic users of this space, while others were unaware of its potential to meet their purposes. Where schools had provided opportunities for teachers to learn about technology, either through giving time for play and exploration, working together or formal professional development, teachers tended to see a clear purpose for using technology.

Reflection

The findings indicate that reflection is less common than action among teachers in this study. While many reflected on their practice, and in mediating learning encouraged students to do so, particularly in primary schools, reflection was often informal and undocumented, and at a low level (Zeichner & Liston, 1996). Some teachers established regular times for their private journal writing or occasional group reflection, and in some cases the school culture encouraged these practices through providing time and space, or mandating journal writing. These practices, along with teacher talk, are important, according to Wenger, for the development of self and also for learning about a wider

world. However, there was little evidence of teachers reflecting together, or reflecting on artefacts such as student products, or in the social reconstructionist tradition: one that would lead to wide-reaching change in schooling, particularly through the designing role. Although reflection is encouraged as a means of improving practice (Darling-Hammond & McLaughlin, 1996) it could be that in their rush to be active and not to waste precious time, some teachers are missing opportunities to imagine new roles and to make new meanings of teaching. Similarly, although many teachers claimed to build theory from their practice, explicit evidence of theory developing from practice (rather than that taken and espoused from external sources) was very rare.

Exploration

There were many signs in this study that teachers valued openness and exploration, both for themselves and their students, but in some cases, teachers felt *governed* and constrained by curriculum frameworks and policy documents. Those who conceptualised curriculum frameworks documents as empty scaffolds waiting to be filled with authentic learning activities were confident in their ability to encourage student exploration and could see the potential for purposeful technology use when designing the learning environment. These teachers recognised that there were choices in technology use ranging from consumption to creation, and focused on the latter. The activities these teachers designed, their management strategies, and their mediation were based on travelling across boundaries. They were supported by a culture encouraging exploration, unlike the teachers who were constrained by school cultures of isolationism and overwhelming accountability. In terms of improving their own practice, exploration cultures supported teachers learning through play (alone or together), although innovation was not dependent on play. Teachers made new connections and created new knowledge in a variety of ways, such as visiting other schools, working with other teachers via video conference and presenting at seminars and conferences.

Facilities of Alignment

Alignment, according to Wenger, affords ways to have an effect on the world and includes three facilities: convergence (for example, shared vision), coordination (procedures and boundary practices) and jurisdiction (including policies and distribution

of authority) as described in Chapter 2. Table 8.5 shows the findings for each role in relation to these facilities.

Table 8.5 How teachers' roles support alignment

	Alignment
Designing	***Convergence*** 4.3 Teachers share a common discourse of planning 4.6 Teachers design in professional collaboration
	Coordination 4.7 Teachers design purposeful tasks 4.9 Teachers design for open ended learning
	Jurisdiction
Managing	***Convergence*** 5.3 Teachers model collaborative knowledge-building and management practices 5.6 Teachers manage connections across boundaries
	Coordination 5.5 Teachers manage relationships between people for authentic learning
	Jurisdiction
Mediating	***Convergence*** 6.8 Teachers and students talk together to increase learning 6.3 Teachers and students monitor and assess learning together
	Coordination 6.1 Teachers help students learn how to learn 6.6 Teachers focus on knowledge-building activities
	Jurisdiction
Improving	***Convergence*** 7.2 Teachers frame personal and social goals for learning
	Coordination 7.6 Teachers freely share their knowledge 7.7 Teachers reflect on their practice and share their reflections
	Jurisdiction 7.9 Teachers contribute to school wide decision-making

Convergence

Convergence within the school communities of practice in this study is supported by teacher leaders articulating a vision, shared understandings of learning, and curriculum frameworks and the common discourse of design that arises from them. However, some teachers in this study could be said to be at the periphery and far from being experts in this field, as for example, the teacher who said "*I am aware of those CSF II documents*

and where learning technologies are suggested to be used, but I haven't really got into that in a big way" (Chapter 4). Across communities of practice, the curriculum and standards frameworks acted as a tool of statewide convergence and coordination, allowing teachers the opportunity for shared discourse and boundary encounters that support professional practice. This was particularly evident in the primary schools where teachers did some of their work collaboratively, within and across schools. In other instances teachers who connected across time and space found that understanding developed as the local discourse was supplemented by a shared discourse. Several teachers in this study have embarked on a practitioner-researcher partnership, which can help make tacit knowledge explicit, develop a shared discourse and take the explicit knowledge of both groups to a wider audience.

Convergence was enhanced where teachers and students worked together on designing, managing and mediating. This increases the possibility of making more teacher knowledge explicit. There were however, few instances of teachers accessing the discourses of other bounded communities with similar interests, either through print or the Internet, although this did take place to some extent during annual Successful Integration of Learning Technologies (SILT) Project celebrations. The focus of convergence among teachers in this study was much more local than global.

Coordination

Coordination implies connection and purpose. After at least a decade of focus on outcomes and accountability, some teachers have appropriated boundary objects like curriculum standards frameworks, and methods such as thinking and planning tools, and implemented them across the school, strengthening the community of practice. All findings which relate to members of the community talking together (either formally or informally) have the capacity to enhance coordination, but in some cases teachers reported barriers such as lack of time or a disinclination of others to be involved. For example, teachers typically design together in primary schools more than in secondary schools, while other classroom roles are still commonly undertaken individually.

Talking regularly opens up possibilities for teachers to articulate tacit knowledge — the glue that holds the community together — even if it is not documented.

Coordination also includes boundary facilities, such as the purposeful tasks linking students with local communities, or solving community problems. This is enhanced by teacher-brokers as described above, who work at the periphery of the community and are aware of their multimembership of several communities (Damarin, 1996). In their mediating role, teachers assist coordination through promoting a discourse among students around learning how to learn, and setting expectations of reflection and sharing knowledge.

Where there was a clear, shared purpose for computer use, and infrastructure such as a school Intranet, technology was used to enhance alignment through the roles of designing, managing and mediating learning. In their own learning, teacher participants referred to plans and goals for performance management and professional development on an individual basis within a shared framework, an expectation of the system. However, none suggested that these could be collective goals, although their purpose is to ensure that the school reaches its goals in terms of student outcomes.

Jurisdiction

The final element of alignment, jurisdiction, was noted generally in relation to school and system policies and procedures. Teachers reported to principals and parents, when requested, on student curriculum outcomes or professional development activities, for example. Although Hargreaves (1999) suggests that schools should cast a wide net by auditing what they don't know as well as what they know, there was little evidence of teachers collecting data other than that mandated by the system. In spite of their extensive knowledge and experience in designing, managing and mediating learning, few teachers displayed broad participation in making explicit their tacit knowledge to inform the shaping of the school beyond their classroom. Even where the possibility of using archived email discussions existed, for example, teachers felt uncomfortable about the potential exposure of their thoughts to others. This reduces the impact of the

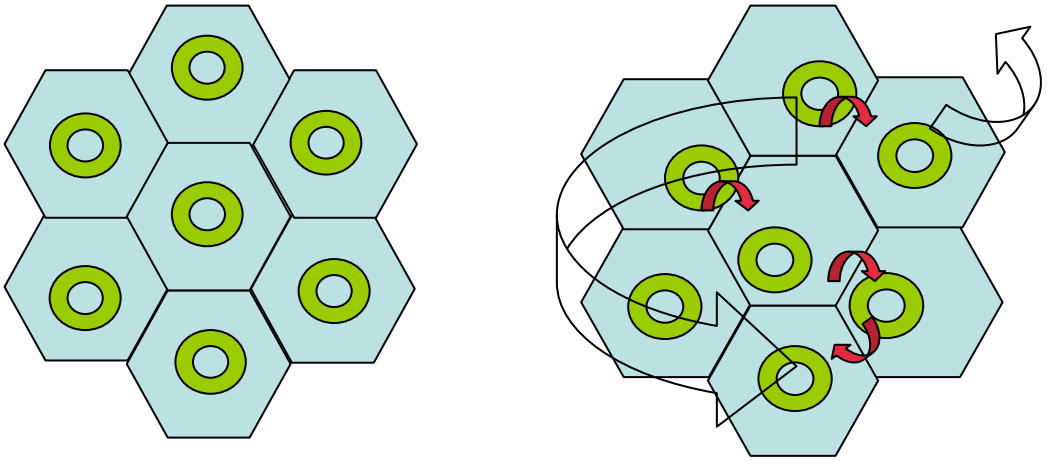
particular learning community of the school on other communities, and in Wenger's terms, reduces its effect on the world.

Islands of excellence and constellations of communities

Taken as a whole, the findings broadly show that many of the characteristics of Wenger's learning architecture exist at the classroom level in the context of the normal structure of one teacher per class. Teachers are particularly interested in enhancing engagement through a constructivist approach, while alignment is encouraged by education systems, by virtue of the fact that they *are* connected systems. However for most, the alignment tends to be more to do with common vision within the community than with having an effect on the world. Imagination — building an image of self and the world — is supported through trust, openness and reflection. This has the effect of deepening and strengthening the teacher-led community of practice, with positive social outcomes. However, differential teacher quality across the whole system (Rowe, 2002) means that schools and systems cannot remain satisfied with this structure. Although some teachers clearly act as brokers to facilitate boundary encounters between the communities in a school and also make links with external communities, others remain as "islands of excellence with no ferry service" (Reilly, 1999, p.1). The belief commonly expressed in primary schools was "*to make this kind of stuff work you can't be a little island in your classroom with your door shut like we used to be"* (Chapter 7), but secondary teachers generally did not express this vision. If communities of practice are to be a useful structure in supporting knowledge building, this individualism is a concern.

A school is a constellation of communities connected both intentionally and by circumstance. This is conveyed in Figure 8.3, which adapts the singular hexagonal model of teachers' roles developed in Chapters 2 and 3 to show how communities of practice currently form constellations, depicted in A. The inner circle represents the teacher, and the hexagon is the classroom community of practice. The continuity of the constellation is then understood in terms of interactions among practices: boundary objects and brokering, as depicted in B. Boundary objects such as documents (and web

sites) that make tacit knowledge explicit (Hargreaves, 1999) assist in sharing knowledge across boundaries, and teacher-brokers are located nearer the periphery than the centre of each community. Their links are indicated by arrows between communities. Some communities look further out and make links even wider afield.



A **B**

Figure 8.3 Islands of excellence and constellations of learning communities

This model can be developed further in light of emerging practice, particularly to include groups of teachers, rather than individuals, in the central ring: a model of collective competencies. The final part of this section illustrates a means of capturing current and emerging practice in schools.

Mapping knowledge building

Although not exhaustive, the findings showed a range of conditions for, and characteristics of, knowledge building, which have been used to develop a framework document designed to promote discussion and to inform teacher professional learning and pre-service education. As foreshadowed, the findings establish some of the expectations for a zone of proximal development for teachers' learning in communities of practice. If teachers wish to develop communities of practice of teachers and learners, in classrooms and across schools, these characteristics can provide a way of mapping current practice and suggesting future action. Accordingly a document based on the findings in Table 8.2 was prepared and shared with participants at the end of 2002. The

core of this document is presented as a list as in Table 8.6 and the version sent out is found in Appendix 5.[3] It provides a framework that can be fleshed out locally by specific practices.

Table 8.6 Mapping knowledge building

1. A shared knowledge of how people learn influences our curriculum planning
2. We design the classrooms/learning spaces to support our philosophy of learning
3. We document our planning models and processes (how we plan)
4. We involve students in planning their curriculum
5. We design and write up purposeful tasks which encourage student collaboration
6. We find curriculum and standards frameworks useful rather than a constraint
7. We link across Key Learning Areas when planning curriculum
8. We use a range of tools in our planning eg. Multiple Intelligences, Hill-Crévola, Mindmaps.
9. We plan with teachers in our own school and other schools
10. We use technology to assist us in our planning
11. We plan for students to use open-ended resources eg Microworlds, Hyper studio.
12. We encourage self-management in our students
13. We share responsibility for student management and model collaborative leadership
14. We model and demonstrate the use of technology to students
15. We ensure that students collaborate when using technology
16. We motivate our students intrinsically through experiencing achievement rather than through extrinsic rewards
17. We encourage students to move around the school whenever their learning requires
18. We are not constrained by the length of class sessions
19. We encourage students to link with adults who support their learning eg. experts, community members, relatives, other teachers
20. We encourage students to use the technology at whatever time they need
21. We can cope with and solve equipment problems: it happens!
22. We believe that learning takes place when students work together to make sense of their world
23. We model good teaching and are often in each other's classrooms
24. We build on students' talents and past experience
25. We actively support students in learning how to learn
26. We engage in dialogue with students both face-to-face and using technology eg. email and discussion groups
27. We focus on open-ended and inquiry activities with students
28. We vary the amount of structure for different students
29. We engage in reflection with students about their learning
30. We constantly monitor learning through teacher and student assessment, including self-assessment
31. We believe all teachers are learners
32. We set personal and group goals for our professional learning
33. We enjoy learning about new ideas and new ways of working
34. We share our knowledge with many other teachers within and beyond this school eg. through presentations, publications, web sites
35. We reflect together on our goals, our practice and on relevant data
36. We modify our practice as a result of reflection
37. We develop theories about learning from our practical experience
38. We use both our experience and data to contribute to making decisions in this school

[3] As noted in Chapter 3, half the participants returned completed maps.

Implications of the findings

The third aim of this study was to suggest implications of the findings for teachers' professional learning and the development of new practices that enhance knowledge building. The broad definition of professional development offered in Chapter 1 includes teachers reviewing, renewing and extending their commitment as change agents to the moral purposes of teaching (Day, 1999). If teachers as professionals are to be more involved in shaping their future roles, some reflection on the shifts towards knowledge building documented in this study will be necessary. The rich description of teachers' thoughts and behaviours will inform programs of teacher education, and professional development at system, school and teacher levels. Improving practice through professional learning will then be much deeper than the conception of professional development often held in the past, and its rationale will include teachers themselves influencing the purpose, form and content of teaching.

Understanding teachers' roles

The findings regarding teachers' classroom roles provided by this study can assist teachers themselves to reflect on and make sense of their emerging roles, particularly in light of the spread of technology and the declared importance of the teacher to student learning. They will then be empowered to act on classroom and school structures as necessary to achieve common goals.

Possibilities with technology

From a constructivist viewpoint, technology has created openings for teachers to take up new roles and new combinations of roles. It provides levers for change through an infrastructure for finding new information and new ways of working, but it cannot create new information without the involvement of people. This can be seen clearly in terms of the designing role. Where teachers understand and use the potential of technology for the whole range of activities from consumption through (re)production to creation, they are designing for knowledge building. Decisions about the design of the physical environment can then be made to support this goal. Similarly, where teachers have a clear sense of the purpose of technology and how it supports knowledge building, they have guidelines for managing people and resources through timetabling arrangements,

remote access and professional collaboration. Technology allows teachers to store and manage knowledge objects efficiently, to build the community's intellectual capital, but as yet for most schools the scope is small, due to limited network capacity and time. Finally, technology has created enough turbulence for teachers to realise that they too are learners, and it has allowed students to challenge the power relationships inherent in classrooms, through asserting their skill authority. The result is often an attitude of shared learning, or teaching-and-learning (Mercer & Fisher, 1998) and the capacity for knowledge building within the classroom. Connections with other teachers, other classrooms and outside experts are a logical extension of this attitude to sharing knowledge. While it is clear that the potential of the investment in technology is yet to be realised, it will be an enabling factor in teachers' conversations around shaping their new roles.

Collective competencies

Reflection with teachers on their roles in this study was intended to reveal their tacit knowledge and to value their experience. A fundamental finding in this regard is that in improving their practice, teachers are moving towards a decoupling of the other three roles, so that different people could design learning environments, manage people and resources, or mediate learning, as has been suggested in the literature (Beare, 2001; Cornu, 2001; Levy, 1996). Although this development is already occurring in the tertiary sector, there is clearly a tension between this decoupling and the social purpose of connectedness expressed by many teachers in this study. However, given the higher knowledge and skills requirements of each role, and the impending shortage of teachers, it must be considered. This study revealed a slight tendency to specialise, so that some teachers were expert in designing technology infrastructure and others curriculum, some were expert in mediating with thinking tools and others through electronic scaffolding. Some had an interest in managing electronic communication through lists and Intranets, while others focused on organising student groups.

Teachers were attempting to cover all three roles, and constantly felt that time was against them, which led to each teacher emphasising different aspects. As a group teachers claimed to spend a lot of their time designing the learning environment, yet they

also allowed many of the pertinent decisions to be made by others (eg. a technical committee, principal, or Key Learning Area leader). Observations verified that managing people and technology resources was a time-consuming role that required some input from teachers, but often teaching expertise was not required to carry it out. Mediating student learning, however, demanded the expertise of teachers in understanding the prior experience and current expectations of students, scaffolding their learning and managing and disseminating the knowledge products created. Although several of the participants felt that separating the roles of teachers would not be desirable, the findings indicate it is already occurring in subtle ways. By presenting singularities (Bassey, 2001) in addition to strongly supported findings, this study has illustrated the range of emphases that individual teachers place on various aspects of their work.

A refashioning of teachers' roles based on a model of collective competencies (Le Boterf, 2000; Levy, 1996), has implications for skill and knowledge development, industrial agreements, performance management and competency regimes, which would need to acknowledge the collective, rather than individual, nature of the work. It also requires an attitude of interdependence leading to concern with the progress of self, others, and the whole school community (Department of Education Employment and Training, 2001; Jones et al., 1995). This emerging context will require more teachers to see themselves as leaders and followers, as experts and novices, as teachers and learners. As such, they will contribute their experience to the decisions made at school and system levels. This contribution intertwines the development of theory from practice and the development of practice based on theory. It opens up the possibility of teachers emphasising different roles at different times, say, over the space of a year, (as often occurs now over the space of a career) or with different classes at one point in time. Thus, a teacher can be designing the environment for some learners while mediating learning for others. In all cases, better systems of knowing and recording what people bring to their work — and what they learn from it — will be required.

Opportunities for professional learning

Within such professional practice, the content of professional development —Day's (1999) "natural learning experiences and planned activities" — will benefit from being based on the principles identified for student learning as outlined through the findings of this study, bearing in mind Wenger's view that a robust design is a minimalist design that allows for emerging opportunities to be taken up. Learning opportunities need to be situated in the sense that they are teacher driven (Clark, 2001) — although not necessarily workplace based — and connected with broad social purpose. Professional development strategies that focus on providing emptiness — space for reflection, collaboration, conversation and debate — will support an emphasis on creation rather than consumption of knowledge. This has implications for those currently responsible for teacher learning in schools, as it places the focus clearly on school communities providing for their needs, and would affect the market for external professional development providers. Teachers at present value face-to-face encounters. Therefore online support for teacher learning needs to be based on an open-ended, constructivist approach which values teachers' prior experience and multiple perspectives. Teachers will use this support where they see a purpose for it and they have access to the required infrastructure.

Some teachers argue that their time is fully used, while other teachers and schools are able to reconfigure their time budget. This is an issue at system and school levels. Teachers might in future spend less time in the classroom and more on supporting learning, as Hord (1997) and Hargreaves (2003) argue, or in designing new learning environments. Such changes have implications for industrial agreements, which would need to recognise the complexity of legitimate teacher roles. Teaching (or teacher learning) would no longer be measured simply by time spent in classrooms or at professional development activities. McLaughlin and Oberman (1996) wonder what teachers would do if given discretionary time. The findings of this study suggest that empty structures allowing for open-endedness of teacher learning opportunities could enhance knowledge building and innovation. Teachers and students learn from activities when they see a purpose for themselves. The opportunities for such purpose-driven

learning need to be available in the pedagogical moment for teachers. Purposeful authentic teacher learning can be embedded in (rather than attached or added on to) curriculum projects, both local and large scale. The skills and knowledge required by different teachers will differ and the notion of a ladder or stages of competence will be replaced by a web of skills, gained through a process that a participant in this study referred to as *hyperlinked learning*. Learning with technology does not occur simply in stages, but in points, or nodes, linked to other nodes, depending on purposes. This means that teachers and students alike can learn to video conference or program robotics when they choose, engaging in creation activities before consumption activities if necessary.

Reflection should continue to be promoted as a means of professional learning. However a wider range of forms of reflection can be used, taking into account its purposes and people's learning styles. In line with the implications of emerging roles, social reconstruction (rather than individual navel-gazing) should be highlighted as a purpose of reflection (Cochran-Smith & Lytle, 2001). The forms of reflection can include and value oral tradition rather than reifying only that which can be printed, so that providing real opportunities for teachers to talk together can be effective. Technology can support this through audio and videotaping and video and teleconferencing, while tools such as the framework in Table 8.6 can guide reflection towards large-scale issues and point to development needs. Teachers themselves need to reflect on, and talk about, emerging roles and role configurations, and this should be a focus of policy at school and system level.

School arrangements

The time and space geography prevailing in schools is a constraint on major changes in role configurations, particularly in secondary schools, but also in many primary schools. The implications for the design and construction of new school buildings and refurbishment include more focus on flexible use of spaces and the capacity for a range of communication technologies. Similarly the time and space relationships between home, school and classroom, including timetables, hours of use and requirements on attendance of staff and students are all issues that should be reviewed in terms of the effect they have on teachers carrying out their roles. Any changes in arrangements must

however, be purposeful and grounded in theory and practice. This means that the characteristics of designing, managing, mediating and improving practice identified in this study should be interpreted for primary, secondary and other school settings.

Understanding knowledge building in communities of practice

As Drucker (1993) and Nonaka and Takeuchi (1995) suggest, the goal and practices of knowledge building have wider application than only to classrooms and schools.

System responsibility

The notion of constellations of communities can be applied to education systems, indicating that this study has implications for the state system in Victoria and more broadly, and for other organisations and corporations. If system decision-makers in education want teachers and schools to engage in knowledge building and innovation they need to ensure that they are engaged in knowledge building through systemic structures and behaviours (Hargreaves, 2003). This requires a balance between system facilities of engagement, imagination and alignment, accompanied by trust in schools and teachers, to enable them to bring about their own transformation. The curriculum and standards frameworks are a case in point. The findings indicate that in some cases teachers feel constrained rather than supported by the extent of the system's accountability frameworks, and their discourse is often framed in system terms to the exclusion of personal theorising and a local discourse of supporting engagement, alignment and imagination. However as familiarity with the purpose and content of frameworks grows, they see them as useful tools to support practice, indicating that systems should provide relatively empty frameworks with a clear purpose, coupled with trust in teachers' capacity to flesh them out in conjunction with students.

School responsibility

At the school level, there is a tension between the need to make processes and outcomes transparent in order to pass on knowledge and corporate memory, and the possibility that as soon as it is documented it is out of date. Again the question of empty frameworks arises: is it more important to produce knowledge or to develop the space in which knowledge can be created? Although Hargreaves (1999) calls for both explicit and tacit knowledge to be articulated, using oral means of communication could suffice in some

cases. A healthy amount of documentation is likely to be that which meets the purposes of its audience, without overload. Documentation for its own sake, or that attempts to reify tacit knowledge, could be more annoying than helpful, and lead to entrenched positions rather than flexibility.

There has been a tendency to focus inwards, exacerbating the cultural divide between primary and secondary schools. While the emphasis on building skills and confidence within the local school community is laudable, it can limit knowledge building by reducing available perspectives and constantly reinventing the wheel. Local communities of practice need to be involved in designing their own learning, but not to the exclusion of other points of view. Hence, communities of practice must cross boundaries and learn the language of other groups in order to share their knowledge, as well as bringing a diversity of perspectives into the community. The current impetus for state schools in Victoria to collaborate as clusters of schools has the potential to enhance this.

Teacher responsibility

If teachers are to develop classroom communities of practice they will need to be very familiar with current frameworks and tools, since it is only then that they can use them as springboards for practice and as empty structures waiting to be filled with authentic activities. They will also need to become more aware of the continuum of technology uses from consumption, through (re)production to creation in order to provide opportunities for all three modes, but particularly creation. They need to involve students more in designing, managing and mediating learning, thus allowing them to move from the periphery to the centre in terms of expertise in learning processes. Student input can be used to improve the middle years experience, and where arrangements in both primary and secondary schools are reviewed, as Hill and Russell (1999) argue, students can contribute to identifying appropriate organisational changes that support knowledge building as described in this study. These strategies would change the usual teacher-student relationships, and therefore could not be implemented without the cooperation of students.

Practitioner-researcher links

Collaborative partnerships whereby classroom communities work together, teacher communities work together and the teacher and researcher communities work together have the potential to generate broader social transformation. Teachers in this study have shown that where there is a culture of learning from each other, the media afforded by technology can assist both in recording and sharing ideas and practices. An intertwining relationship would focus on teachers as research partners with external researchers. This would assist to meet Hargreaves's (1999) aim of supporting teachers with research skills, without taking their attention away from teaching practices.

While some of the implications appear minor, they require cultural change, and in the first instance, the capacity to take risks. But since learning involves taking some risks, it is time that teachers were freed as professionals to join the ranks of the *interacting* rather than being viewed as passive participants: the merely *interacted* (Castells, 1999).

Coda

Teachers, researchers and teacher educators form a triad, each focusing on their specialty, but acting in collaboration. Further research in partnership would capture both the development of these partnerships and the ensuing knowledge, in projects that test the generalisability of the findings of this study in other types of classrooms such as literacy, numeracy, creative arts; with other age groups and in other combinations of physical and virtual environments. School-based action research can be used to test the potential for disaggregation of roles among teachers in schools. This could be embedded in curriculum projects implementing new technologies, rather than added on to teachers' regular work. The tools developed through this study could be used as a basis for reflective practice by teachers in conjunction with researchers, while further documentation projects where researchers work with teachers to capture their perspectives and practices for sharing more widely would also be valuable.

Unlike Illich (1971), this study has not questioned the need for schools and teachers, but like Castells (1999), makes an assumption that schools will remain as physical communities. It has concentrated on describing classroom activity from the teachers' perspective and as much as possible, through teachers' voices. As such, it provides a contribution to the current state of knowledge about teachers using technology in relation to classroom life. With its focus on social theory, the study does not cover the cognitive processes of learning in any depth, but attempts to identify social processes and structures that will assist knowledge building and the continued learning of teachers, in more efficient and effective ways than previously. The choice of ethnography (rather than a critical ethnography approach) to investigate the research questions means that the findings are more descriptive than evaluative. My approach was generative, inductive, constructive and subjective (Goetz & LeCompte, 1984), but did not attempt to address social reconstruction explicitly.

As was discussed in Chapter 3, conducting the research within the Successful Integration of Learning Technologies (SILT) Project created both opportunities and constraints, particularly in the selection of participants. I originally expected all teachers to be more

confident and innovative users of technology (due to the initial advertising for SILT participants), but soon realised that a study more representative of the bulk of teachers rather than early adopters would yield valuable data. It is possible too, that the involvement of the Department of Education and Training in the Project created certain teacher expectations which were not able to be met, especially in terms of the professional development that could be offered. The interpretive nature of the research meant that there was no ZPD identified for teachers at the outset, and no intervention or scaffolding designed to push teachers to new learnings.

Teachers who participated in this study were always pressed for time. As the conversations clearly required time and space additional to teachers' daily work, they were often difficult to arrange, although teachers appeared to value them when they took place. Somewhat ironically for a study championing flexibility, changes in school organisational arrangements often interfered with appointments that had been made to observe classes or conduct conversations. Accordingly in spite of a large body of data, there were inevitable gaps, and video for reflection was used less frequently than originally intended. Notwithstanding this, the mode of conversation provided opportunities for teachers to openly raise issues rather than simply responding to a set of research questions, and enhanced the possibility of a partnership between the participating teachers and the researcher.

In terms of data analysis, as discussed in Chapter 3, coding became a recursive practice following leads, loops and connections in the data. While there might be simpler ways to categorise data, this method was beneficial to gain a deep understanding of teachers' perspectives, especially as I had been out of school settings for some years. The findings that emerged from the data are clearly an interpretation influenced by a constructivist approach, and they provide a rich description of teachers' classroom practice. Knowing what teachers currently do is essential for their further learning. The discrete role labels developed in this study can be clearly understood by teachers and researchers. I temporarily entitled one role *leading and managing people and resources,* but felt the title was cumbersome, even though it captured a notion of the teacher as leader, which

could be explored further. Since the study is designed to inform teacher learning, if the role descriptions prove to be useful to teachers reflecting on their work, and to teacher-educators, they will have served a purpose.

The analysis of data and presentation of findings was deliberately chosen to reveal useful and emerging practices, rather than to develop a picture of the general state of teaching. There was also an attempt to illustrate the extent of teachers' zones of proximal development (Vygotsky, 1962). Hence the selection of material to support the propositions ranged along continua of both theories and practices. The findings of each chapter are intended to indicate that it is likely that knowledge-building teachers possess certain characteristics that can inform future learning opportunities for teachers.

Community of practice is a term that has recently crept into educational discourse, but it is not always described in detail. As my study proceeded, I discovered through reading, observation and conversation that the notion of community of practice gave insight into the findings, while the findings could flesh out the concept. I considered Wenger's theory helpful as it provided an architecture that was appropriate for housing the substance of my findings. To do this I considered students and teachers as part of the community of knowledge builders, but focused on the teachers' points of view, as the resources devoted to the inclusion of student voices would have meant a reduction in the depth of teacher data.

This study has clearly not reified technology, but has seen it as part of the emerging context for knowledge building. People are the important players in a social theory and the role of technology is to support them in their endeavours. The study has shown several aspects of this enabling role.

Finally, in reflecting on my personal learning process over the past three years I can honestly say that returning to school settings for this study has been a powerful learning experience, underpinning my hope for the future. I was reminded that teachers want to make a difference in students' lives and are keen to explore how best to do so. I valued

the sense of partnership as we reflected together on their practice, crossing the discourse and cultural boundaries between researchers and practitioners. As a former teacher of over twenty years, I came to reflect on my own beliefs and my teaching in a new light. In fact I felt my passion for teaching rekindled and came to understand the meaning of Eliot's words: "to arrive and know the place for the first time" (Eliot, 1963). This I attribute to the benefits obtained through engaging in intertwined action and reflection with others. As a result I believe that innovation and knowledge building will depend on educators and learners from all settings working in a more holistic way, engaging in both action/exploration and reflection, in building theory from practice, and sharing both their explicit and tacit knowledge.

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Appendix 1: Approvals and Consent

1. Letter from Department of Education, Employment and Training, September, 2000
2. The University of Sydney Consent Forms for students, parents and teachers
3. Letter from The University of Melbourne re Program Approval on transfer from The University of Sydney, December 2001
4. The University of Melbourne Consent Forms for staff, parents and students

Department of
Education, Employment and Training

Office of Schools

School Community Support Branch
Level 2, 33 St Andrews Place

SOS001617

5 September 2000

Professor Peter Cuttance
Faculty of Education
University of Sydney
81/187 Canterbury Road
St Kilda West 3182

Dear Professor Cuttance

Thank you for your application of 9 August 2000 in which you request permission to conduct a research study in government schools titled: *Successful Integration of Learning Technologies (SILT)*.

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. Should your institution's ethics committee require changes or you decide to make changes, these changes must be submitted to the Department of Education, Employment and Training for its consideration before you proceed.

2. You obtain approval for the research to be conducted in each school directly from the principal. Details of your research, copies of this letter of approval and the letter of approval from the relevant ethics committee are to be provided to the principal. The final decision as to whether or not your research can proceed in a school rests with the principal.

3. As a matter of courtesy, you should advise the relevant Regional Director of the schools you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director.

4. Any extensions or variations to the research proposal, additional research involving use of the data collected, or publication of the data beyond that normally associated with academic studies will require a further research approval submission.

5. At the conclusion of your study, a copy or summary of the research findings should be forwarded to me at the above address.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Louise Dressing, Senior Research Project Officer, School Community Support Branch, on 9667 2349.

Yours sincerely

JOHN ALLMAN
A/Manager
School & Regional Operations

encl.

THE UNIVERSITY OF SYDNEY
School of Educational Psychology, Literacies and Learning
Building A35 • The University of Sydney • Sydney • Australia 2006
Telephone 0413 990 907 • Facsimile (02) 9615 0049

Ref: SILT Consent Proformas 000822

August 22, 2000

SILT Research Project

Dear Principal

I am attaching teacher and student consent forms for the SILT project.

The University of Sydney Ethics Committee has approved the SILT project, and for the data collection phase, requires that we seek consent from participating teachers and students.

Attached are separate student and principal/teacher consent forms, to be completed by participating students (countersigned by parents/guardians), and teachers/principals.

As the Ethics Committee requires that these consent forms be completed before classroom observations involving interaction between students and the researchers are conducted, we would appreciate it if you could arrange for these to be signed and returned to the school by Monday 28th August.

Yours sincerely,

Professor Peter Cuttance

THE UNIVERSITY OF SYDNEY
School of Educational Psychology, Literacies and Learning
Building A35 • The University of Sydney • Sydney • Australia 2006
Telephone 0413 990 907 • Facsimile (02) 9615 0049

Ref: SILT Consent Proforma 000822

August 22, 2000

Information Statement and Consent (School Staff)

The project *successful integration of learning technologies in schools* (SILT) investigates the role of computers in learning in school classrooms. The researcher is working with teachers to learn more about this. The research leader responsible for this project is Professor Peter Cuttance, School of Educational Psychology, Literacies and Learning, the University of Sydney, Sydney 2006. Ph. 0413 990 907.

As a Principal/Teacher (delete as appropriate) we would like to ask your permission to observe your school and your classroom. The researcher will negotiate with you about these observations. They will require no more than an average of about 15–30 minutes of your time each week over the year in which you are involved.

Your participation is voluntary and you can withdraw at any stage.

Please print your name here .....

and sign to indicate that you give approval for the research to be undertaken

(signature) .....

Any person with concerns or complaints about the conduct of a research study can contact the Manager of Ethics and Biosafety Administration, University of Sydney on (02) 9351 4811.

Please return the completed consent form to your researcher and retain a copy for yourself.

THE UNIVERSITY OF SYDNEY
School of Educational Psychology, Literacies and Learning
Building A35 • The University of Sydney • Sydney • Australia 2006
Telephone 0413 990 907 • Facsimile (02) 9615 0049

Ref: SILT Consent Proforma 000822

August 22, 2000

Information Statement and Consent (Students)

The project *successful integration of learning technologies in schools* (SILT) investigates the role of computers in learning in school classrooms. The researchers are working with teachers to learn more about this.

As a student in the classroom we would like to ask your permission to observe your learning and for you to complete various puzzles and respond to various statements and information that the computer, researcher or teacher, will present to you as you undertake your work.

Please print your name here ..... and sign to indicate that you give approval for the research to be undertaken

(signature) .....

Also, please ask your parent/guardian to sign this form to indicate that they give approval for your involvement in this research.

Parent/guardian's name .....

(signature) ..... Date .....

Any person with concerns or complaints about the conduct of a research study can contact the Manager of Ethics and Biosafety Administration, University of Sydney on (02) 0413 990 907.

Please return this consent form to your Teacher when it is completed

THE UNIVERSITY OF MELBOURNE

Associate Professor Marjorie Theobald
[illegible]

10 December 2001

Prof. Peter Cuttance
Director
Centre for Applied Educational Research

Dear Peter

This refers to our conversation of 8 November 2001.

As your PhD. students, Jean Thompson, Greg Neal and Elizabeth Hartnell Young, had received Ethics Approval from Sydney University and have now transferred their candidature from Sydney to Melbourne (or rather, started afresh at Melbourne), I see no reason why they should not use the data they have already collected while enrolled at Sydney University for the continuation of their research projects at Melbourne University. These PhD projects have been subsumed under the Program Approval that you have received at Melbourne University.

Associate Professor Marjorie Theobald
Chair, Arts, Education and Architecture
Human Research Ethics Committee

[illegible]

Centre for Applied Educational Research
G401 Alice Hoy Building
Faculty of Education
The University of Melbourne 3010
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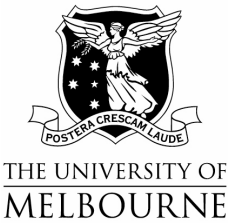

Professor Peter Cuttance
Director

Ref: SILT Ethics Consent 040901.rtf

Innovation & Best Practice Research Program (SILT)

Dear Principal

I am providing teacher and student consent forms for the Innovation and Best Practice Research Program (IBPRP) which includes the SILT Project.

The University of Melbourne Arts and Education Human Ethics Sub-Committee has approved the project and requires that we seek consent from participating teachers and parents of students before any engagement in the research.

Attached are separate parent/student and principal/school staff Information Statements and Consent Forms.

The Consent Form for parents/students requires that the parent or guardian sign the form. The student is also required to sign the form.

I should appreciate you arranging for the respective Information Statements to be distributed and the Consent Forms to be completed and returned to you.

The researcher working with your school will collect the completed forms and arrange for them to be returned to the University of Melbourne for secure storage.

Yours sincerely,
Professor Peter Cuttance

Ref: SILT Ethics Consent 040901.rtf

SILT Information Statement and Consent Form (School Staff)

The SILT project is part of the *Innovation and Best Practice Research Program*, which is researching effective practices for teaching and learning in Australian schools. The researcher (Elizabeth Hartnell-Young) is working with your school to learn more about effective teaching and learning. The research leader responsible for this project is Professor Peter Cuttance, Director, Centre for Applied Educational Research at the University of Melbourne.

The University of Melbourne Arts and Education Human Ethics Sub-Committee requires that these Consent Forms be completed before the researchers can engage with students and staff.

Please read this Information Statement and complete the attached Consent Form and return it to your Principal. The researcher working with your school will collect the completed forms and arrange for them to be returned to the University of Melbourne for secure storage.

> The researchers request your permission to observe your school and your classroom. The researcher will negotiate with you about these observations. Generally, the research will not require you to do anything other than your normal teaching. The researcher will negotiate their involvement and activities in interacting with your students and yourself before each occasion. The researcher will use a range of techniques to record the research data and information: including surveys and written notes; recording by computer, audio and video; and collection of examples of the teaching and learning materials in the classroom.

Your participation is voluntary and you can withdraw at any stage by notifying your Principal. You are also free to withdraw your consent at any time by writing to Professor Peter Cuttance at the address above.

> The data will be used for research purposes, including conference presentations, and professional development activities. You will be provided with the opportunity to view and approve or veto the presentation or publication of any data that could identify you.

If and when the data is deemed no longer of interest it will be destroyed by means that ensure that retain its confidentiality, for example by shredding, incineration or reformatting of electronic storage media such as computer disks.

Please indicate that you have read, understood and give your consent by initialling each of the statements on the Consent Form and sign at the bottom of the form.

Should you require any further information, or have any concerns, please do not hesitate to contact either your researcher or Professor Cuttance on 03 8344 8201. Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 7507, or fax: 9347 6739.

Professor Peter Cuttance

SILT Consent Form FOR School Staff & Principal
Innovation & Best Practice Research Program
I *[Print Name]* …… consent to participate in the above project, the purposes of which have been explained to me to my satisfaction.

Please initial each of the following statements to indicate that you have read and understood them and that you give your consent in relation to each of them.

		Teacher's Initials
(a)	*I consent to the research gathering information about my teaching and the school learning environment through the use of surveys, interviews, direct observation, audio recording, video recording and computer recording/logging of data.*	.....
(b)	*I consent to be interviewed at times agreed with the researcher and for the interview to be recorded through the use of surveys, direct observation, audio recording, video recording and computer recording/logging of information.*	.....
(c)	*I consent to the use of the recorded video material for the purposes of conference presentations and teacher professional development, on the condition that I have the prior right to veto the use of any specified data that identifies me for such purposes and that I will be provided with the opportunity to view and approve of all such information prior to its use in this way.*	.....
(d)	*I consent to the researcher utilising any material that is used in my teaching and the school learning environment for the purposes of the research. My authorisation will be required in each case where this involves the removal of material from the teaching and school learning environment.*	.....
(e)	*I acknowledge that I am free to withdraw from the project at any time and to withdraw my consent for the use of any data that could in any way identify me and to delete any information that identifies me.*	.....
(f)	*I acknowledge that the purpose of the project is for the improvement of teaching and learning.*	.....
(g)	*I have been informed that the data will be treated as confidential and securely stored so as to be available only to researchers who has formally agreed to the above conditions for the use of the data, consistent with the above conditions and subject to legal requirements.*	.....

[Teacher's Signature] ……..……..…..… *[Date]* ……..……I *[Print Name]* …….. , Principal of *[Print School Name]* ……..... authorise the researcher to work with the teacher above under the conditions specified herein. *[Date]* ……

Ref: SILT Ethics Consent 040901.rtf

THE UNIVERSITY OF MELBOURNE

Information Statement and Consent Form (Parents and Students)

The *Innovation and Best Practice Research Program* is researching effective practices for teaching and learning in Australian schools. The researcher is working with your school to learn more about effective teaching and learning. The research leader responsible for this project is Professor Peter Cuttance, Director, Centre for Applied Educational Research at the University of Melbourne.

The University of Melbourne Arts and Education Human Ethics Sub-Committee requires that these Consent Forms be completed before the researchers can engage with students and staff.

Please read this Information Statement and complete the attached Consent Form and return it to the Teacher of your child. The researcher working with your school will collect the completed forms and arrange for them to be returned to the University of Melbourne for secure storage.

As a Parent of a Student in the classes that will be studied, the researchers request your permission to observe the school and classroom, including your child's activities in the learning environment. Your child will not be expected to undertake any activities other than the normal learning program at the school and to interact with the researcher in the classroom and afterwards to discuss their learning.

The researcher will negotiate with the teacher about their interaction with students in the classroom and after the lesson so as to ensure they do not disrupt teaching and learning in the classroom. The researcher will require no more than an average of about 30 minutes of time each week over the year in each classroom and your child will be interacting with the researcher for only part of this time.

The researcher will use a range of techniques to record the research data and information: including, surveys and written notes; recording by computer, audio and video that may include your child, and collection of items used and developed in the learning environment.

The participation of all students is voluntary and you can withdraw your consent at any time by notifying the teacher or writing to Professor Peter Cuttance at the address above.

If and when the data is deemed no longer of interest it will be destroyed by means that ensure that retain its confidentiality, for example by shredding, incineration or reformatting of electronic storage media such as computer disks.

Please indicate that you have read, understood and give your consent by initialling each of the statements on the Consent Form and sign at the bottom of the form.

Please explain the project to your child and ask them to sign the form to give their consent to participate in the research.

> Should you require any further information, or have any concerns, please do not hesitate to contact Professor Cuttance on 03 8344 8201. Should you have any concerns about the conduct of the project, you are welcome to contact the Executive Officer, Human Research Ethics, The University of Melbourne, on ph: 8344 7507, or fax: 9347 6739.

Professor Peter Cuttance

CONSENT FORM FOR PARENT OR GUARDIAN

Innovation & Best Practice Research Program
I *[Print Name]* …… consent to the participation of my child *[Name of Child]* …… in the above project, the purposes and processes of which have been explained to me to my satisfaction.

Please initial each of the following statements to indicate that you have read and understood them and that you give your consent in relation to each of them.

		Parent's or Guardian's Initials
(a)	*I consent to the research gathering information about my child through the use of surveys, interviews, direct observation, audio recording, video recording and computer recording/logging of data.*	.....
(b)	*I consent to my child being interviewed at times agreed with the teacher and the child and for the interview to be recorded through the use of surveys, direct observation, audio recording, video recording and computer recording/logging of information.*	.....
(c)	*I consent to the use of the recorded video material for the purposes of conference presentations and teacher professional development, on the condition that I have the prior right to veto the use of any specified data that identifies my child for such purposes and that I will be provided with the opportunity to view and approve all such information prior to its use in this way.*	.....
(d)	*I consent to the researcher utilising any material that is used in my child's learning environment for the purposes of the research.*	.....
(e)	*I acknowledge that I am free to withdraw my child from the project at any time and to withdraw my consent for the use of any data that identifies my child.*	.....
(f)	*I acknowledge that the purpose of the project is for the improvement of teaching and learning.*	.....
(g)	*I have been informed that the data will be treated as confidential and securely stored so as to be available only to researchers who have formally agreed to the above conditions for the use of the data, consistent with the above conditions and subject to legal requirements.*	.....

[Parent's or Guardian's Signature]……..…..…..… *[Date]* ……..……
[Contact Phone Number or Address] …….

Please explain the project to your child and ask him/her to sign below to indicate their consent to participate in the project.

I *[Student's Name]* …… understand the purpose of this research and consent to my participation in it *[Student's Signature]* ……

Appendix 2: Pilot Study

A pilot study was conducted in late 2000 in order to trial selected research methods. It aimed to add to the understandings in the literature by describing and classifying the range of teacher roles and associated behaviours in a range of primary and secondary classrooms through observation and conversations with teachers. Table A2.1 shows the characteristics of the teachers observed.

Table A2.1 Characteristics of teachers observed in classrooms using computers

Teacher	Age range	Years teaching	Laptop	Gender	School type	Number of observations
012	25-29	3	Yes	Female	Primary	1
004	30-39	9	Yes	Male	Primary	1
009	40-49	12	No	Female	Secondary	2
001	30-39	14	Yes	Male	Secondary	3
007	40-49	18	No	Female	Secondary	3
002	40-49	19	Yes	Male	Secondary	2
013	40-49	22	Yes	Female	Primary	1
018	40-49	23	Yes	Female	Primary	2
014	40-49	24	Yes	Female	Secondary	1
020	50-59	29	No	Male	Primary	1

The age range generally reflects the Victorian teaching service, which has an average age of nearly fifty years, and few teachers in their twenties. The years of experience teaching generally match with age, indicating that teaching has been the main career, except for one woman (Teacher 9). Three teachers (30% of the sample) did not have a laptop computer, although one had made application at this time. Eighteen observations were undertaken in the teachers' classrooms during Terms 3 and 4, 2000. Some teachers were observed more than once depending on their availability. In each case there was at least one computer available in the classroom, although these were not always in use during observations. As I moved about the classroom I made handwritten notes, including verbatim quotes. The particular areas of interest were teacher behaviour, including use of technology and the extent of teacher talk to whole class, groups and individuals. I rarely interacted with teachers or students unless it was initiated by others. Following the observation I wrote up the notes in detail, coded the documents using QSR N4 Classic (Richards, 2000) and classified the data to show the range of current teacher roles.

Findings

The main working relationships observed were between teachers and students, and students with students. There was rarely more than one adult in any classroom, and if so, these were teachers-in-training, technical support staff or librarians. The following vignette from a secondary classroom shows the types of classroom activity observed during the study.

A secondary classroom (school A, teacher 001)

The class of ten female and twelve male Year 8 students has entered the computer lab, which was booked well in advance by their teacher. It is the first class of the day, scheduled to last for 45 minutes. In the lab are twenty-four computers arranged in four rows at right angles to the front of the room, but the monitors are angled towards the back. The room is painted lemon and is fairly light as the heavy curtains on the outside windows are drawn back. Each student sits at a computer. There is a whiteboard and a projection screen at the front of the room, next to the door to the storeroom and technician's office. The computers are all linked to a network across the school and have Internet access.	Planning location Designing layout
The teacher has previously written instructions for the class, which is researching Antarctica, on the whiteboard. They read: YEAR 8 GEOGRAPHY Due date 1. Research 2. Do questions A A Internet sites Search	Planning curriculum Managing content
"A A" refers to a CD-Rom on Antarctica produced by Attenborough, which the students have used previously. The teacher, a male with nearly twenty years' experience, has also prepared a set of questions, which are printed on paper and have been given to the students previously.	Planning
At 8.57 am he speaks to the class as a whole. "Open your diaries please everyone. This project is due Wednesday 18 October: Week 3, Term 4" He refers to the instructions on the whiteboard. "Continue researching Antarctica. You can use the Attenborough CD ROM, the Internet through the GTAV web site, or a normal search. You can work by yourself or in a group. We will bring in boxes of books from the library. Some questions have been chosen because there is material in your textbook." The students listen quietly as the teacher continues.	Managing people
"I will turn the computers on. Attenborough is not installed on all computers. With the headphones: if there's two of you will need a double adaptor. I'll get the disks." These instructions take six minutes, after which a student asks the teacher: "Are you allowed to print off?" The teacher replies, "Yes" and goes into the adjoining storeroom to turn on the computers. He comes out saying, "Computers are now on. Double adaptors are here." Some students come forward to collect adaptors. It appears that the technical assistant has not turned up as expected to set up the resources.	Managing technology
The teacher asks, "Now where's Sarah?" as he must not allow her to use the Internet. It appears that the Computer Coordinator has banned Sarah from	Managing People

using the Internet because she accessed the staff home page. The teacher reinforces this message to Sarah without any fuss. Most students seem to be settling into the work as listed on the whiteboard. One female student commences a general search for Antarctica on the Internet, while another asks the teacher for advice re accessing the CD. After some discussion it seems that it is not available on her computer. Students are talking among themselves about the tasks. One doesn't remember what question to answer. "Don't you think we have way too much time?" he says to another student. "I'm going to use Corel DREAM (the 3D editing program). I need to remember what my password is." One male student asks the teacher "If we find information can we print it?" and the teacher replies "Yes".	Managing technology
Teacher moves around the room observing the students and the material on the computer screens. He engages in conversation with them a little.	Monitoring
Several students are using the school home page as a portal to the Internet. It has been set up so that each key learning area has a searchable section, but students are free to access other search engines such as Google or Ask Jeeves. The school uses a filter to stop students accessing unwanted material, particularly with sexual references. Students have space on the school file server to store their own digital material or downloaded information. One male student is unable to access the Internet as he can't remember his password, which he changed recently. The teacher cannot help, as he does not have a list of all student passwords, so the student will have to find this out from a technician at another time. Students on individual computers are talking to each other about the content and tell me they are working together for some of the tasks. Most (except Sarah) are using the Internet, while some are using the CD Rom on Antarctica. One male student is looking through the History in the Internet browser to find a site he'd used before and found interesting.	Managing technology
Students are collecting the information in various ways. Some are copying from the screen on paper such as the girl who is writing untidy notes and tells me she will sort it out at home. She has nothing saved to her web space and hasn't brought a floppy disk to transport her files. The teacher points out to me that some of the girls, presumably like this one, are not as experienced with technology as the boys. In contrast, a male student is researching krill and saving the information to his server space, also with the intention of working on it at home. However a female student, working on a travel brochure, tells me will look up all the information and store what she wants in her server space, to print out later. "Or I could just email it to myself" she adds.	Monitoring
At 9.19am, the teacher says, to noone in particular "Now the stupid printer's broken", as the material sent by one student is not coming through the printer. He makes some suggestions to the student about dealing with this problem and moves away.	Managing technology
The teacher draws to my attention two female students who have summarised the Antarctic treaty by reading, selecting parts and pasting into Word. He tells them they must also note the web site as a reference for their Bibliography.	Monitoring Coaching
At 9.27 am all appears peaceful in the computer lab, with students working quietly. But eight minutes after he first mentioned the printer, the teacher is now trying to stop the print command. Repeated pages sent to the printer by one student are wasting paper. The teacher does not know what to do, but tries a few ideas at the student's monitor. The technician, who has by now arrived, comes into the room and fixes the problem by resetting some aspects	Managing technology

of the computer. The student would have been unable to do this, she tells me, because they are not permitted to go into the Explore function as they can delete files that way.	Managing people
One female student who appears not to want to use technology in her presentation, asks the teacher "Am I able to do my project in book form? The teacher replies that he prefers to see a variety of formats.	Coaching
Groups of male students are using Microsoft Image Composer to manipulate an image of krill downloaded from the Internet. One is trying to take the black background off. Another asks the nearby students "Do you know any sites about the weather" and is immediately given "weather.yahoo.com" by another boy. These students explain to me that they're doing a radio program for their presentation and have found material on scientific reports. By now, though, it is 9.37 am and the teacher tells the whole class: "All right, we've got about 2 minutes".	Managing people
A female student who has been using the school's Internet search facility need to record a bibliographic reference. She has gone back to Google but can't find the reference in the header bar. She doesn't know what to write, so the teacher suggests something so that others will be able to find the site. While this discussion is occurring, other students are packing up their headphones and other equipment and leaving the lab for their next class.	Coaching

From transcripts like the one above, the observed behaviours of teachers were broadly categorised in light of the literature as *managing people and technology*, *mediating* (which includes demonstrating, coaching, instructing, monitoring and assessing and reflecting) and *improving practice or learning*. *Designing* was also included because many teachers referred in class to their prior or future planning, and showed evidence of this during observations. Examples of teacher behaviours are shown in Table A2.2, with the evidence taken directly from observation notes and teacher comments. The evidence from specific teachers is labelled with their 3-digit identification number.

Table A2.2 Teachers' observed classroom behaviours

Teacher Behaviour	Examples	Observed	Evidence
Designing	Participating in sessions with other teachers to plan topics and activities from brainstorms with students; preparing assignment sheets; timetabling computer room access; testing software; research on Internet.	Teacher 1,4,5,6,9,10,12,13,18	Teacher tells me it took him 2 hours to work out how to use the CD. He then wrote sheets to assist students in navigation which took 2 hours, and another 2 hours was spent on a question sheet (male, secondary teacher). [001]
Designing	Teachers give general guidelines re expected products; direct students to previously cached Internet sites; require structure in documents and presentations,	Teacher 2, 7, 8, 12,13	Teacher explains to me that students established own questions to research after brainstorm, then emailed their proposals to her and negotiated via email (female, primary teacher). [012] "Have a look on your web page. There

	including bibliographies.		are assignment tasks female, secondary teacher). [008] Students are preparing a PowerPoint presentation, a précis of written research they have already completed using Internet and books as resources (female, secondary teacher) [007]
Managing People	Teachers allocate access to the computers in structured or loose manner, organise mentor/tutor pairs with one skilled in technology and one novice; discipline whole class or individuals; motivate and dispense rewards.	Teacher 1,2,4,7,9,12,13,14, 20	“Now where's Sarah?” (Sarah is banned by the Computer Coordinator from using the Internet because she got into the staff home page) (male, secondary teacher). [001] Teacher reminds mentors to sit back and not do all the work. "Now you people on the computers take in everything the mentors say. The mentors are giving up their time to help you (female, primary teacher). [018] Teacher asks "Hands up who wants to be on computer?" Hands go up, she indicates to individual students and says "1,2,3,4,5,6" that's the computer you're on (female, secondary teacher). [014]
Managing Technology	Teachers allocate hardware resources; turn computers and peripherals on and off; rectify hardware and software problems; advise students where to store projects eg on network or disks.	Teacher 1,2,7,8,9, 12	Teacher says pictures can be taken from Internet or can be scanned. "Let me know and we'll make sure the scanner is hooked up next time" (female, secondary teacher). [007]
Mediating (demonstrating)	Teachers show students a process using software or a sample product; take computer mouse to show students how to complete a procedure. Sometimes done with large monitor or AVER key.	Teacher 1,7	Teacher goes to two girls who have selected template - takes mouse and shows how text box will come up. Teacher using mouse, shows student how to précis information (female, secondary teacher). [007]
Mediating (coaching)	Teachers work one on one or with small group to guide students in completing a procedure; encourage students to consider different aspects; relate commands in new software to programs the students are familiar with; use open-ended questions to lead students; encourage students to use graphics, to read and rewrite information;	Teacher 1,7,10,12, 13	Teacher suggests to student some additions to the navigation information in Microworlds, suggests some instructional writing in text box (female, primary teacher). [012] Teacher spends time in centre of room "conferencing" with groups of about 6 students. Uses open ended questions with students and often positive responses eg "That's a great suggestion" (female, primary teacher). [013]

Mediating (instructing)	Teachers tell how to use software to individuals or whole class. Sometimes other teachers instruct re software prior to or during the class.	Teacher 1,7,8	"Now, I used the whiteboard and I said this is basically what I want you to use. You go to somewhere, you get a clue, you go somewhere else and you do clues off those sites." (female, secondary teacher). [008] Teacher gives instructions about the CD, suggests students click around the screen (male, secondary teacher). [001]
Mediating (monitoring and assessing)	Teachers move around room keeping track of student progress; keep students on task; give feedback; comment on the design, spelling and grammar in PowerPoint presentations; allocate marks and grades to presentations and other tasks.	Teacher 1,2,4,7,13, 18	Teacher makes notes about student findings and asks students to present new things they've found so others can learn about them (female, primary teacher). [018] Students are presenting PowerPoint prepared to meet set criteria. Teacher assesses the talk at 3/5, will tell the students next week (male, secondary teacher). [002] Teacher assessing Microworlds content and teamwork, uses laptop to record numbers in assessment grid and announces score after each group demonstration (male, primary teacher). [004]
Mediating (reflecting with students)	Teachers use thinking tools to encourage questioning among students; encourage individual reflection at end of session.	Teacher 4, 12	Teacher has all students sit on floor for reflection on content and how the groups worked (female, primary teacher). [013]
Improving practice	Teachers acknowledge a lack of knowledge and seek new information in new ways; reflect on own planning and management and student responses.	Teacher 2,18,20	Teacher says he has learnt how to do PowerPoint from the students (male, primary teacher). [020] Teacher says "I don't know how it's done" so student shows her (female, primary teacher). [018]

After the initial observations, teachers from the six schools were invited to participate in a semi-structured conversation around SILT Item 2: Teacher beliefs and attitudes, which is found in Appendix 3: Data collection tools. The areas for discussion included the ideal learning environment, student motivation, teacher control and enjoyment of technology. The original ten teachers observed and another six teachers from the six schools, plus one other, responded. The additional teachers had the characteristics shown in Table A3.4. This added five more teachers who had a laptop computer. The gender remained fairly evenly balanced, although the number of primary males is higher than might be expected in Victoria, while more of the additional teachers were from primary schools. Their teaching experience ranged from six to twenty-two years.

Table A2.3 Characteristics of additional participating teachers

Teacher	Age range	Years teaching	Laptop	Gender	School type
003	25-29	6	Yes	Male	Primary
008	40-49	14	Yes	Female	Secondary
011	30-39	15	Yes	Female	Secondary
010	30-39	16	Yes	Female	Primary
006	40-49	21	No	Male	Primary
005	50-59	22	Yes	Male	Primary

One teacher (014 — female, secondary) was not available for the conversation. Six conversations of approximately 45 minutes (one per school) were taped during 2000 and recording failure marred the seventh. Each teacher was involved in one conversation and the survey forms were collected at this time. The schedule of conversations that took place over six weeks, in the fourth term of 2000, is shown in Table A2.5.

Table A2.4 Conversation dates and participants

Date	School Type and ID	Participants
29 August	Primary D	Teacher 5,6,10
13 September Tape failure	Primary H	Teacher 18, 20
5 October	Primary B	Teacher 3, 13
9 October	Secondary E	Teacher 7
12 October	Secondary F	Teacher 8,9,11,
13 October	Secondary A	Teacher 1,2
16 October	Primary C	Teacher 4, 12

In addition to the conversations, two teachers (Teacher 004 and Teacher 012) provided journals documenting their reflections. These had been written during 2000 for professional development purposes within the school, and were offered to me as data. These data, together with the conversations revealed a great deal of evidence of teachers' beliefs or espoused theories, and at this stage it became clear that many teachers felt strongly that they were learners. Both primary and secondary teachers expressed this belief and appeared comfortable with this role, as these commented:

> *I think it has to do with the fact that the students not only are learners, but also the teachers. They can teach the teachers and that is the onus of responsibility and I feel like I'm involved as much as any…They know as much if not more than I do, so it's not so much me teaching them, it's just a sharing of information*

and knowledge usually as needs arise, if it's working (male, primary teacher). [004]

You learn a lot of new stuff, some of it you learn from the children, some of it you learn as you go along. Because you try to find out how to do this, or what's going on, so you learn a lot (male, primary teacher). [005]

The classification of three roles of teachers (Table A2.5) was found to be useful and appropriate, while the teacher as learner was seen to be a role in relation to all the others.

Table A2.5 Three main roles of teachers in classrooms

Designing learning environments	**Managing people and resources**	**Mediating student learning**
Planning the curriculum Designing physical and virtual spaces	Managing technology Managing content Managing people	Instructing Demonstrating Coaching Reflecting Monitoring and Assessing

The pilot study indicated that the ethnographic approach and the methods of observation and conversation appeared likely to yield useful data, while the conceptual framework was further developed as described in Chapter 3.

Appendix 3: Data Collection Tools

1. SILT ITEM 2: Teacher beliefs and attitudes
2. Letter to teachers, 2001
3. SILT Project: Conversation on teacher roles 2002

SILT ITEM 2: Teacher beliefs and attitudes

Please make notes on this sheet and bring it to a conversation with the SILT researcher in your school, where you can discuss your responses, and hand it back

Your name	School name
Gender (please circle) **M** **F**	Age range 18-24 25-29 30-39 40-49 50-59
DEET laptop: **YES** **NO**	HOME COMPUTER: **YES** **NO**
How long have you been teaching? …….years At this school?……..years	Current responsibilities:

1. Beliefs about teaching and learning

• Describe your ideal student learning environment.	
• Do you believe all students want to learn?	
• To what extent should the teacher control the learning of students?	
• How important is it to encourage autonomous learning in students?	
• How do you address the individual	

styles of students in the SILT class?	

2. Attitude to technology (please write brief responses as notes for the conversation)

• Do you believe that technology can improve the quality of teaching and learning? How?	
• To what extent do you enjoy working with technology in the classroom? Why?	
• How has using technology changed your students' learning?	
• How important is it for you to learn new skills and new uses for technology?	

Thankyou

23 March 2001

Dear SILT Teacher

Thank you for your participation in SILT research last year. I have some preliminary material that I would be happy to share and discuss with you. My major need at this stage is to observe more classes in action.

I would now like to arrange a visit to your school before the end of Term I or early Term 2.

The purpose will be to observe you and your class using some computer technology. I will be making notes and doing some videotaping. To enable this to occur, the consent forms which were sent to you recently need to be signed by you and by any students in the class to be observed.

Immediately following the class, I would like to spend some time (perhaps 20 minutes or so) looking at video snippets and reflecting on the class with you. I would like to audiotape this reflection. This would mean the class has to be before a break or some of your preparation time.

Please contact me soon for more information and to arrange a suitable time.

Yours faithfully

Elizabeth Hartnell-Young

SILT Project: Conversation on teacher roles 2002 (to be taped)

Please bring this sheet to the conversation with Elizabeth Hartnell-Young

Name……

School ……

Gender (please circle) M F	Age range 18-24 25-29 30-39 40-49 50-59
How long have you been teaching?	Current teaching responsibilities:

Teacher roles conversation schedule

Hedley Beare predicts that with greater use of computers in schools, the role of the teacher will change dramatically. He suggests the familiar functions will be broken up and rearranged into new bundles of activities.
In the SILT project so far, it seems that teachers are involved in three major roles:

- designing the learning environment, including the physical layout, the curriculum and resources;
- leading and managing people and resources; and
- mediating student learning.

You are also actively involved in your own learning.

I am interested to find out from you

- what emphasis teachers put on each of these roles in classrooms using computers (what you think should be done and what you can actually do)
- any changes which are occurring, or will in the future
- which tasks all teachers need to do and which could be shared or discarded
- resources and activities which have been valuable for your learning

Of course you are welcome to raise other issues too.

Thank you

Elizabeth

Appendix 4: Notes on Data Analysis

The analysis of data commenced almost as soon as it was collected. The data were generally in the form of words (such as curriculum documents, electronic journals, transcripts of conversations and observation notes) with some accompanying images. To convert all data to digital form would have been a massive task, so print documents were read thoroughly and relevant passages selected for conversion, generally through retyping. Photographs were stored on paper and scanned to digital formats, and video clips were selected from the videotape and converted to short movies using iMovie or still images. Some short movies were transcribed as conversations. Demographic information (gender, school type) was stored within the transcription files to assist in finding patterns as the analysis went on.

After conversion to digital formats, the text data could be coded. In the early stages, QSR N4 Classic (Richards, 2000) was the program chosen for this task. After considering the pilot study data in light of the literature and my prior views, a set of categories of teacher roles appeared to emerge from a grounded approach, and these were used to code later data. Where initial conversations followed the structure of SILT Teacher Survey 2, this provided a framework for part of the coding. Other emerging themes included physical layout, types of technology use and comments on change related to technology. Within each theme sub-categories were established based on what was (or in some cases, was not) mentioned in the data. All text data irrespective of source type were coded with reference to the resulting categories. Chunks of text (often more than 100 words) were selected to maintain a sense of context where appropriate, although in some cases, shorter phrases were enough to capture a thought. Images illustrated various physical layout codes, teacher and student behaviours and student outcomes. The coding framework is illustrated at three points in Table A4.1 below.

Table A4.1 Coding Framework

Base data	Gender school type classroom type (added Oct 01)	Gender Male Gender female School type Primary School type Secondary Classroom Type A} all Classroom Type B} added Oct 01 Classroom Type C} C&D collapsed Classroom Type D} Mar 02
belief re technology	Definite Dependent negative	
Enjoy using technology	positive negative	
Ideal learning environment (added Oct 01)	student centred teacher centred	
student change thru technology	attitude interactions output outcomes	
teacher learns new skills	formal informal other	 informal/from students informal/from teachers
Beliefs about students' capacity to learn	positive negative	
student styles	individual groups other	
autonomous learner		
Assess/measure improvement	formal informal student assess	
issues	access to technology school culture time other	
reflect	academic social efficiency developmental social reconstructionist generic	

Teacher role	planner content manager people manager technician instructor demonstrator coach mediator-scaffolder confidant monitor-assessor dispenser of rewards reflector learner improve role/change (added Mar 02)	
student behaviour	type A production type C	
teacher behaviour (added Mar 02)	Use of /email teacher control	

By the start of the final year of the study 60 categories had been labelled, numerous reports were generated on categories and matrices, and propositions began to arise from the data. Merging categories was an option to simplify data handling. Some codes appeared to be very close in meaning, but portrayed nuances in the data, although some text segments had also been coded under several categories. Instead of merging, I chose to return to a completely holistic view of the data. All text data were reviewed and in some cases transcripts reconsidered with the original tapes in light of the developing propositions. The text search feature of Microsoft Word and the Sherlock content finder proved adequate for a thorough combing of all text data for the use of specific words, while QSR N4 Classic was revisited for broader scale analysis. It was revealing to find that several teachers in the study reiterated their positions and ideas over the period, and that conversation and observation data from individuals were often quite congruent. At this time an email distribution list was set up by some of the teachers in the study. All messages on this list were archived separately as evidence of a developing sub-project within the SILT Project.

After the choice had been made, I analysed the selection according to teacher and school identification. This revealed some interesting, but unsurprising, patterns. A summary of the selections by chapter is shown in Table A4.2.

Table A4.2 Quotations used by participant and chapter

	Ch 4	Ch 5	Ch 6	Ch 7	Total
001	5	5	2	4	16
002	1	1	1	0	3
003	1	0	3	1	5
004	8	15	11	17	51
005	1	2	4	1	8
006	0	0	1	2	3
007	5	3	6	9	23
008	4	11	5	2	22
009	1	0	2	0	3
010	0	3	6	1	10
011	1	0	0	2	3
012	1	4	2	3	10
013	2	4	8	0	14
014	0	0	0	0	0
015	2	4	2	6	14
016	8	6	3	0	17
017	0	0	0	3	3
018	2	6	2	3	13
019	4	0	1	0	5
020	0	0	0	3	3
021	2	3	3	4	12
022	3	5	2	10	20
023	2	2	2	5	11
024	1	1	2	12	16
025	4	1	5	1	11
026	1	4	1	0	6
027	1	1	1	0	3
028	1	0	1	1	3
029	0	0	0	0	0
030	0	1	0	0	1
031	0	0	2	2	4
032	0	0	1	1	2
Total	61	82	79	93	315

The data in the table reflect to some extent the relationship developed with particular teacher and schools. For example, Teacher 004 gave many comments on a range of topics during visits, on email and through journal writing over the complete period. On the other hand Teacher 017 participated in only one group conversation and was not observed, while teacher 014 was only observed. Due to the non-interventionist nature of the study, teachers and schools drove much of the contact, and the level of involvement differed. However all played a part in building up the picture of communities of practice discussed in this study.

Gender was considered as the literature indicated that it may have an effect on computer use (Delaney & Dyson, 1998; Hakkarainen et al., 1999; Ravitz et al., 2000). However, it appeared not to be significant at the level of analysis of this study: that is, males and females were equally likely to be collaborative, or to tinker, or to espouse constructivist approaches.

Appendix 5: A Map of Knowledge Building

A DIY map of knowledge building

Please score each item from 1-3, shading in the appropriate column. If the item is not part of your **personal** practice, please use N/A.

N/A = does not apply to me/us
1 = only applies to me individually
2 = applies to my team & some other groups in this school
3 = is part of our school culture

Your name School

Item	N/A	1	2	3
1. A **shared knowledge** of how people learn influences our curriculum planning				
2. We **design** the classrooms/learning spaces to support our philosophy of learning				
3. We **document** our planning models and processes (**how** we plan)				
4. We **involve students** in planning their curriculum				
5. We design and write up purposeful tasks which encourage **student collaboration**				
6. We find curriculum and standards frameworks **useful** rather than a constraint				
7. We **link across** Key Learning Areas when planning curriculum				
8. We use a range of tools in our planning eg. Multiple Intelligences, Hill-Crévola, Mindmaps..				
9. We plan with teachers in our own school and other schools				
10. We use technology to assist us in our planning				
11. We plan for students to use **open-ended resources** eg Microworlds, Hyperstudio..				
12. We encourage **self-management** in our students				
13. We share responsibility for student management and **model collaborative leadership**				
14. We model and **demonstrate** the use of technology to students				
15. We ensure that students **collaborate** when using technology				
16. We motivate our students intrinsically through **experiencing achievement** rather than through extrinsic rewards				

17. We encourage students to **move around** the school whenever their learning requires				
18. We are not constrained by the length of class sessions				
19. We encourage students to **link with adults** who support their learning eg. experts, community members, relatives, other teachers				
20. We encourage students to use the technology at **whatever time** they need				
21. We can cope with and solve equipment problems: it happens!				
22. We believe that learning takes place when students **work together** to make sense of their world				
23. We **model** good teaching and are often in each other's classrooms				
24. We build on students' talents and past experience				
25. We actively support students in **learning how to learn**				
26. We engage in **dialogue** with students both face-to-face and using technology eg. email and discussion groups				
27. We focus on **open-ended and inquiry activities** with students				
28. We vary the amount of **structure** for different students				
29. We engage in **reflection** with students about their learning				
30. We constantly **monitor learning** through teacher and student assessment, including self-assessment				
31. We believe all teachers are learners				
32. We set personal and group **goals** for our professional learning				
33. We enjoy learning about new ideas and new ways of working				
34. We **share our knowledge** with many other teachers within and beyond this school eg. through presentations, publications, web sites				
35. We **reflect together** on our goals, our practice and on relevant data				
36. We **modify our practice** as a result of reflection				
37. We develop **theories about learning** from our practical experience				
38. We use both our experience and data to contribute to **making decisions** in this school				

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Title:
Towards knowledge building: reflecting on teachers' roles and professional learning in communities of practice

Date:
2003-05

Citation:
Hartnell-Young, E. A (2003) Towards knowledge building: reflecting on teachers' roles and professional learning in communities of practice. PhD thesis, Department of Education Policy and Management, The University of Melbourne.

Publication Status:
Unpublished

Persistent Link:
http://hdl.handle.net/11343/38933

File Description:
Towards knowledge building :|breflecting on teachers' roles and professional learning in communities of practice